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PATHOGENICITY AND CULTURAL EXPERIMENTS WITH CALICIOPSIS PINEA [1]

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(WITH 6 FIGURES)

The ascomycetous fungus, *Caliciopsis pinea* Peck, is apparently not uncommon in eastern North America on white pine, *Pinus Strobus* L. It has been observed frequently on this host in the region of Ithaca, New York, during the past fifteen years. It occurs also on a number of other coniferous hosts, and has been found in western North America and in Europe. On white pine it is often associated definitely with sharply delimited cankers on the trunk and larger branches. Fitzpatrick (**1920**: 226), who discusses the species taxonomically in his monograph of the Coryneliaceae, states that the fungus is parasitic and the cause of the formation of the cankers. He emphasizes the fact, however, that his statement is based wholly on field observations and is unsupported by results of artificial inoculations. Overholts (**1930**: 235) also says that the fungus is parasitic, and states that small saplings have been noted by him to die where no other

[1] The substance of this paper was presented before the Mycological Society of America at its annual winter meeting at Pittsburgh, Pennsylvania, December 27, 1934, by Professor H. M. Fitzpatrick.

[2] The writer wishes to express his appreciation to Professor H. M. Fitzpatrick for suggesting and supervising this investigation.

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agency that might have been responsible for their death could be found. The importance of white pine as a forest tree makes the study of the disease of special significance, and, as adequate proof of the parasitic nature of the fungus had not been provided, the inoculation experiments, here reported, were undertaken.

On white pine the fruit bodies of *C. pinea* are found on the surface of cankers of two quite distinct types. Those of the type which in our experience is the most common are round depressed areas in the cortical tissue (FIG. 2). They are sharply delimited, and their characteristically reddish-brown color, contrasting with the gray background of the normal bark, renders them visible at a considerable distance from the tree. Though often small, they may attain individually a diameter of several inches and are frequently confluent (FIG. 3). Large branches and even the trunk may thus be completely encircled. Though these cankers are commonly rather superficial, the injury is sometimes deep enough to involve the cambium. The other type of canker was first mentioned by Overholts. In this case the canker occurs "in most pronounced form just below the branch whorls" and bears a "resemblance to the extreme roughening of the bark caused by the pine woolly aphis." Apparently it is in connection with the formation of cankers of this type that the greatest injury to the tree results. We have often observed the fruit-bodies of *Caliciopsis* on the surface of the roughened bark at the axils of the branches of living and dead trees, though definitely delimited cankers have not in all cases been distinguished. Doctor George H. Hepting of the Division of Forest Pathology of the United States Department of Agriculture in a letter to Doctor Fitzpatrick alludes to the tendency of *Caliciopsis* to fruit on the roughened bark at the axils of the branches in white pine and states that he examined one tree about ten feet high which had about half of its twigs under one inch in diameter apparently killed by this fungus. He states further that he has observed *Caliciopsis* throughout the Appalachian Mountain Region from Maryland through Georgia where it occurs commonly on *Pinus Strobus, P. echinata,* and *P. virginiana.*

Many of the small, sharply delimited, reddish-brown cankers formed on white pine are devoid of fungus fruit-bodies of any

FIGS. 1–6. *Caliciopsis pinea.*

kind. Not infrequently, however, the surface of the canker bears the small erumpent, black stromata of *Caliciopsis*. As the stroma develops, small hemispherical lobes appear over its surface. Many of these lobes undergo further development to form flask-shaped spermagonia containing small hyaline spermatia. Others elongate into spine-like columns (FIG. 5), which are destined to contain the asci and spores. As the column approaches maturity it enlarges at the apex, and within the enlargement a single ascigerous locule is developed. The column is black and glabrous and attains a maximum length of 2 mm. (FIG. 6). The apical swelling containing the ascigerous locule may collapse in drying and have a compressed aspect. During the late winter and spring, the asci mature their spores. The tip of the column finally opens by an indistinct pore through which the ascospores are extruded. They tend to adhere in a mass about the opening in the form of a powdery brown plug which is at length disintegrated by wind and rain. The spores are unicellular, subglobose, and light brown.

Cultures of the fungus were obtained from ascospores by the dilution plate method. Also small bits of cortical tissue taken from the edges of cankers and planted in agar plates gave rise to pure cultures of the fungus. The cultures derived from the spores were identical in every respect as to cultural characteristics with those obtained from the diseased tissue.

Inoculations.—Small pieces of agar bearing the mycelium of these cultures were inserted in tiny slits made in the bark of healthy white pines under conditions previously rendered as sterile as possible. In other cases a heavy spore suspension was employed, a few drops being inserted in similar slits in the bark. Also a number of slits were made to serve as checks, no fungus material being inserted. All of these cut areas were kept covered for a week with moist absorbent cotton. These inoculations were made in the spring of 1934. By the autumn of the same year well defined reddish-brown, sunken areas, identical in aspect with the cankers commonly observed on white pine were present where inoculations had been made. During the spring of 1935 stromata appeared on several of these. Spermagonia have formed on these stromata, but no stromatic columns containing ascospores have appeared as yet in August, 1935. Thus, it is evident that from

the time of inoculation to the formation of spermagonia and stromatic columns a period of considerable length has elapsed. No cankers were found in any of the controls.

As a result of these artificial inoculation experiments, the conclusion seems warranted that *Caliciopsis pinea* is parasitic on white pine and the cause of the typical cankers above described. Judgment as to the importance of the disease in the nursery and forest must be deferred until more extensive field studies have been made.

Additional inoculations have been performed during the spring of 1935 on other coniferous trees in an effort to gain additional information concerning host range, but not enough time has elapsed to warrant evaluation of the results.

Cultural characteristics.—Since no account concerning the culture of this fungus was found in the literature, experiments dealing with the growth, cultural characteristics, and production of spermagonia and stromatic columns have been performed.

It is a simple matter to remove ascospores with the point of a needle from the apex of the stromatic column, but they have a tendency to cling together in clusters, probably because of the gelatinous layer which surrounds each spore. Attempts to separate the spores in connection with the pouring of dilution plates were not wholly successful. At least, there was no certainty that individual spores had been obtained. To make sure of getting single spores, use of the micro-dissection apparatus proved necessary. Single spores, isolated with it, were placed in nutrient broth in sterile depressed slides and allowed to germinate and grow until the mycelium filled the drop of broth. Then with a needle the mycelium was transferred to agar plates.

A number of media were tested in the effort to find one upon which the fungus would grow and produce fruit-bodies. The mycelium grew slowly on 2 per cent potato-dextrose agar, oat meal, malt, beef, cornmeal, and media made with the decoction obtained by boiling white pine bark or wood. The growth on cornmeal was slightly more vigorous than on any of the other media used. On cornmeal small brown bodies appeared in the depths of the medium and to a lesser degree on its surface. These bodies occurred singly or in small clusters and gradually became darker. When mature they were found to be spermagonia containing minute spermatia.

The mycelium grew very slowly, seldom filling a 100 millimeter petri dish within a period of eight weeks, and formed a very tough mat on the surface of the agar which was cut with difficulty. There was far less mycelial growth within the depths of the media. The color of the colony varied from a buff to a dark brown, and often a zonate appearance was given by the presence of dark and light bands. Microscopic examination revealed in many cases the fusion of several hyphal elements to form rhizomorph-like strands. Because, on cornmeal, growth was good and spermagonia were produced abundantly, this medium was adopted for all further work. Many plates were planted with single spore, polyspore, and canker tissue isolates. Within four to eight weeks spermagonia appeared in all the plates. Those on the surface exuded white drops of spermatia. Although several such series were run using cornmeal agar alone, no stromatic columns were produced, even when artificial spermatization was performed.

It was suggested that if blocks of white pine bark, sterilized in the autoclave, were placed in plates of cornmeal agar the spermagonia might be formed on the surface of the wood where spermatization could take place more favorably. Hence, such blocks were placed in petri dishes, and agar was poured in and allowed to solidify around them in such a way that only their upper surface was left exposed.

Single spore isolates were planted in these plates in pairs in all possible combinations, a planting being made on each side of the oblong pine block. Plates containing only one of the single spore isolates were also made, as well as single isolates from cankered tissue. Within six weeks the mycelium had grown well, and along the exposed surface of the bark, where the mycelium of the two plantings met, there was formed a line densely covered with spermagonia. A smaller number of spermagonia were found on both sides of this definite line. The spermagonia were small, flask-shaped to globose bodies occurring singly or in groups on a branched structure. White opaque drops of spermatia oozed from the spermagonia (FIG. 4). No attempt at artificial spermatization was made, and eventually the cultures dried without having formed mature stromatic columns.

Another series of plates similar to those mentioned above was made. To one set of these, when the spermatia were oozing, was added sterile distilled water. This was agitated, and allowed to remain covering the culture for several hours, after which the excess was poured away. To the other set of plates no water was added.

Several weeks later in one plate containing a pair of single spore isolates, there appeared structures comparable to the stromatic columns produced in nature (FIG. 6). These arose among the spermagonia, and formed in a definite line (FIG. 1). In duplicate plates made with the same two single spore isolates, some of which were spermatized artificially, while the others were not, stromatic columns appeared in a few plates of each kind, but not in every plate. In only two of the many plates just mentioned were ascospores produced. The remaining plates dried out before maturity was attained.

In some of the other plates containing other isolates singly or paired, structures resembling stromatic columns appeared but did not mature.

Repetition of these experiments gave similar results, but in none of the plates did the columns which were produced become wholly mature and spore bearing. The fact that the columns reached maturity in only two cases of the many trials may be due to the long time required by the fungus for fruiting, and because of the difficulty experienced in preventing drying out and contamination of the cultures.

SUMMARY

1. Inoculations with mycelium and spores from pure cultures have demonstrated that *Caliciopsis pinea* Peck is parasitic on white pine and causes the formation of sharply delimited cankers on the trunk and branches.

2. In pure culture spermagonia and mature stromatic columns containing asci and spores have been developed.

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LITERATURE CITED

1. **Fitzpatrick, H. M.** Monograph of the Coryneliaceae. Mycologia 12: 206–267. 1920.
2. **Overholts, L. O.** Mycological Notes for 1928–1929. Mycologia 22: 232–246. 1930.

EXPLANATION OF FIGURES

Photographs by W. R. Fisher. Fig. 1, stromatic columns forming a definite line on a block of white pine surrounded by cornmeal agar in a petri dish, × 2¼; 2, rounded cankers on white pine, the narrow sinuous white lines being due to the work of insects, nat. size; 3, small cankers on white pine coalesced to form larger cankers, nat. size; 4, clusters of spermagonia produced in culture showing exuding drops of spermatia, × 13; 5, a portion of a small canker on the surface of which are groups of spermagonia and stromatic columns, the white area being due to the exudation of resin, × 2; 6, some of the mature stromatic columns produced in culture on the blocks of white pine bark, × 9.

RELIQUIAE KAUFFMANI

JOHN DEARNESS

When the late Dr. C. H. Kauffman was overtaken by his last illness there remained a number of his collections undetermined. About sixty of them were submitted to me for examination including thirteen which are here described as new species.

The collections were made by Dr. Kauffman himself except where otherwise stated. Compared co-types were returned to be deposited in the herbarium of the University of Michigan. The descriptions are arranged in the order adopted in Clements and Shear's Genera of Fungi.

ASCOMYCETES

Trematosphaeria cornina Dearn. sp. nov.

Perithecia evenly but not thickly scattered, cartilaginous, black, shining, usually 0.66 mm. in diameter, embedded in the cortex, subglobose, somewhat flattened above but ascending to the short, wide ostiolum about 120 μ above the surrounding level of the bark without rupturing it, appearing clypeate. Asci very variable, averaging 125 $\times$ 15 μ, range 105–140 μ $\times$ 12–36 μ, thick-walled sometimes up to 10 μ at the top; densely paraphysate. Ascospores one to eight in an ascus, brown, elliptic with narrowed ends, 4–6-celled, variable in size, the largest in asci with few spores, 24–38 $\times$ 12–20 μ, obliquely uniseriate or biseriate or irregular.

On dead branches of *Cornus* sp.; Harlan, Ky.; Sept. 6, 1916. (D. *8077b.*)

Curreya Corni Dearn. sp. nov.

Stromata grayish pustules with black centers, 1–1.25 mm. in diameter, rising above the bark level about 0.5 mm., bulging the bark to half their height and then rupturing it into a close fitting collar. Locules 1–3 in a stroma, internally black, shining, if single nearly globose, short necked, 0.5–0.7 mm. in diameter. Asci soft, transparent, evanescent, variable in shape and size, usually

8-spored, reaching 150 × 30 μ in a mass of indefinite paraphysoids. Ascospores brown, muriform, uniseriate or irregularly biseriate, oblong-elliptic, contracted towards the ends but not acutely, varying from 21 × 12 to 66 × 18 μ with 1–8 transverse septa and 0–3 longitudinal septa shorter than the ascospore.

On dead, 1 cm. thick branches of *Cornus* sp.; Harlan, Ky.; Sept. 6, 1916. (D. *8077*.)

Euryachora Neowashingtoniae Dearn. sp. nov.

Stromata black, shining, rough, clypeate, intracuticular, circular with a single locule and then about 300 μ in diameter, or subcircular with 2–3 locules and about 1 mm. in diameter, often confluent and irregular. Loculi 75–225 μ, one to several in a stroma, breaking the clypeus into a stellate or irregular rupture. Asci not numerous, globose, 42 μ in diameter or variously saccate, 105–30 μ when nearly oblong, 8-spored; aparaphysate. Ascospores hyaline, mucous-sheathed, 1-septate, constricted, upper cell usually rounder than the lower one, 20–28 × 9–10.5 μ.

On dead petioles of *Neowashingtonia filifera* var. *robusta;* Miami, Fla.; Feb. 11, 1919. (D. *8064*.)

Hysteropsis guajava Dearn. sp. nov.

Hysterothecia in the wood surface, shining black or dull black when thinly covered with fibers, cleft most of their length, 125–500 μ parallel to the fibers, 50–120 μ in width. Asci cylindric, clavate or saccate, thick-walled, stipitate or almost sessile, 35–85 × 10–17 μ varying with the seriation of the ascospores and the length of the stipe, shorter usually than the paraphyses. Ascospores hyaline, muriform, oblong-elliptic, with 3–5 transverse septa and one partial longitudinal septum, 15–18 × 8–9 μ.

On decorticated wood of a living guava tree,—*Psidium guajava;* Miami, Fla.; Feb. 24, 1919. (D. *8078*.)

PHOMATALES

Phoma Anemones Kauff. sp. nov.

Pycnidia thinly scattered, subcuticular, ostiolate, 120–160 μ in diameter, hemispheric to subglobose, arising from brownish or amber colored hyphae. Conidia hyaline, bacillar, some of them

curved, 5–6.5 × 1.25 μ, on filiform conidiophores produced from relatively deep plectenchyma.

On dead stems of *Anemone virginiana;* Ann Arbor, Mich.: June 6, 1920. (D. *8069.*)

Dr. Kauffman had proposed this name; his notes are incorporated. *Phoma regina* Fairman inhabits *Anemone* but its conidia are of different shape from these.

Naemosphaera pinicola Dearn. sp. nov.

Pycnidia scattered, long-beaked, superficial, subglobose, dark brown or black under the lens, membranous, thin-walled, 120–130 μ in diameter; beak 0.6–1.5 mm. long, very narrow, 90 μ thick at the base gradually reducing to 50 μ at the top where it bears a short, hyaline sheath. Conidia numerous, pale brown, subelliptic, 7–8 × 4–5 μ.

On pine shavings in a saw-dust pile; Ann Arbor, Mich.; May 15, 1929. Coll.: R. McArdle. (D. *8080.*)

Sphaeropsis cornicola Dearn. sp. nov.

Pycnidia very thickly scattered, black, showing the small ostiola through a cruciform rupture of the epidermis, 0.3 mm. in diameter, connected by branching brown hyphae in the cortex. Conidia pale brown, oblong with rounded ends, contents homogeneous, 15–17 × 6–7 μ on obscure, narrow, short conidiophores.

On dead branchlets of *Cornus* sp.; Cabin John, Md.; Dec. 12, 1918. (D. *8068.*)

Rhabdospora Arctii Kauff. sp. nov.

Pycnidia thickly scattered, black, subcuticular, 80–140 μ in diameter, 45 μ deep, wall thin; ostiola cylindric, 15–30 μ long. Conidia hyaline, straight, 19–21 (24) × 0.8–1 μ on short conidiophores up to 15 μ long; hymenial layer 30 μ thick.

On dead stems of *Arctium minus;* Ann Arbor, Mich.; June 6, 1920. (D. *8073.*)

Camarosporium Ceanothi Dearn. sp. nov.

Pycnidia thickly scattered, low, small, black pustules, 150 μ, rupturing the epidermis by a narrow cleft. Conidia hyaline at first

becoming amber brown, 1–3 septate, usually muriform, on conidiophores up to 12 × 1.25 μ.

On dead twigs of *Ceanothus americanus;* Takoma Park, Md.; June 13, 1918. (D. *8062.*)

Associated with perithecia containing immature asci, 15 × 3.75 μ, without paraphyses.

Cornularia harpographoides Dearn. sp. nov.

Pycnidia or synnemata on large, laminated lenticels, mostly in a circle near the edge of the lenticel, rarely on the unbroken bark, black, nearly smooth, 0.75–1.25 mm. in height, 150 μ thick at the base, 75 μ thick near the top just below the slight capitulum. Conidia hyaline, narrowly crescentic, ends acute, 1–3 septate, 28–35 × 3–3.5 μ, the septation made visible by staining; conidiophores fasciculate-branching, 1–1.25 μ thick.

On what appears to have been living or languishing branches of *Crataegus* sp.; Jackson, Mich.; July 13, 1917. (D. *8065.*)

Dr. Kauffman's note reads "on scale insects." I found the pycnidia only on large lenticels with an exceptional one on the bark.

Cornularia Populi Dearn. sp. nov.

Pycnidia thickly scattered, black, shining, superficial, subgelatinous, membranous, columnar, contracting upwards, sometimes from an enlarged basal portion, usually single, perforate at apex, sometimes clustered and connate at the base suggesting a valsoid group of ostiola, 0.7–0.9 mm. long and where single 140–180 μ thick at the base and 60–90 μ at or near the top, internally lined with conidiophores. Conidia hyaline, linear, but somewhat thickened in the middle, obscurely 1-septate, 10–11.5 × 1–1.4 μ; conidiophores linear about one and a half times the length of the conidia.

On firm, decorticated, dead poplar,—*Populus* sp.; Ann Arbor, Mich.; June 9, 1909. (D. *8085.*)

Neopatella Kauffmani Dearn. sp. nov.

Pycnidia thinly scattered, black, wall brown-cellular under magnification, subglobose, umbilicate, rough, becoming patellate with a stellate or irregularly divided border, erumpent, 250–350 μ in diameter, rising about 100 μ above the bark. Conidia hyaline, con-

tinuous, homogeneous or guttulate, evenly or falcately crescentic, exceptionally semi-circular, acute at the ends, sometimes obtuse at one end, 21–32 × 5–7 μ, on short conidiophores, 2–3 μ wide.

On dead branches of *Fraxinus americana;* Rock River, Mich., near Lake Superior; Aug. 30, 1927. (D. *8088.*)

MELANCONIALES

Septogloeum parasiticum Kauff. & Dearn. sp. nov.

Acervuli scattered on living branchlets up to 6 mm. thick under an epidermal covering about 75 μ deep, their position indicated by minute ruptures which in this collection are usually surrounded by whitish pulverulence of exuded conidia, 1 mm. in the longer diameter of the base, the portion of median vertical sections which react to eosin stain 225 μ in depth of which 30–35 μ is the thickness of the conidiophore layer. Conidia hyaline, oblong with rounded ends, granular, 3-septate when mature, 28–52 × 12–15 μ, exuding in slightly pinkish pulverulence; conidiophores of various lengths, 10–45 × 3 μ.

In the cortex of *Ulmus americana,* causing the shriveling of the leaves and the death of affected branchlets; in swampy ground north of Eloise, Mich.; June 2, 1917. (D. *8084.*)

The name was proposed by Dr. Kauffman; his notes are incorporated in the description.

SOME AUSTRALIAN HETEROBASIDIOMYCETES

G. W. Martin

(with 2 figures)

Through the kindness of Professor J. B. Cleland, of the University of Adelaide, I have been permitted to examine twenty-six collections of Australian Heterobasidiomycetes, mostly from South Australia, a number of which proved to be of unusual interest. Among the common and widespread species represented were *Exidia glandulosa* Fries, *Tremella frondosa* Fries, with brownish spores and basidia (*Phaeotremella* Rea) and *Exidia nucleata* (Schw.) Burt. Of the last-named species there were no less than six collections, all from South Australia, suggesting that this species may be as common there as it is in temperate North America. All of these species are mentioned in Dr. Cleland's recent publication [1] but certain of them call for special comment.

Sebacina (Bourdotia) megaspora Martin. In Cleland, Larger Fungi of S. Austr. 334. 1935 (fig. 1: 1–12). The description is printed in English in the work cited, without Latin diagnosis. It seems advisable to amplify the description and to append a Latin diagnosis and figures showing the microscopic characters.

Fructificatio ceracea, effusa, 1 cm. lata, gregaria, fuliginea vel subavellanea, in sectione 600–1000 μ crassa, ex hyphis 1.5–2 μ crassis densis contextis constituta; gloeocystidia frequentia, ex hyalino lutescentia, 30–60 × 6.5–7.5 μ; probasidia subglobosa, 18–28 μ diam.; basidia longititudinaliter septatis; sporae hyalinae, simplices, uno latere depressae, 24–30 (–38) × 11–14 (–16) μ.

Effused in small associated patches, each up to 1 cm. in extent, soft waxy, thin, somewhat cerebriform, dark grayish brown to dingy watery drab and semitranslucent and 600–1000 μ thick when soaked, drying to a dull, blackish brown film; hyphae slender, 1.5–2 μ in diameter, intricately branched and anastomosing, with

[1] Cleland, J. B. Toadstools and mushrooms and larger fungi of South Australia. Part II. Adelaide. 1935.

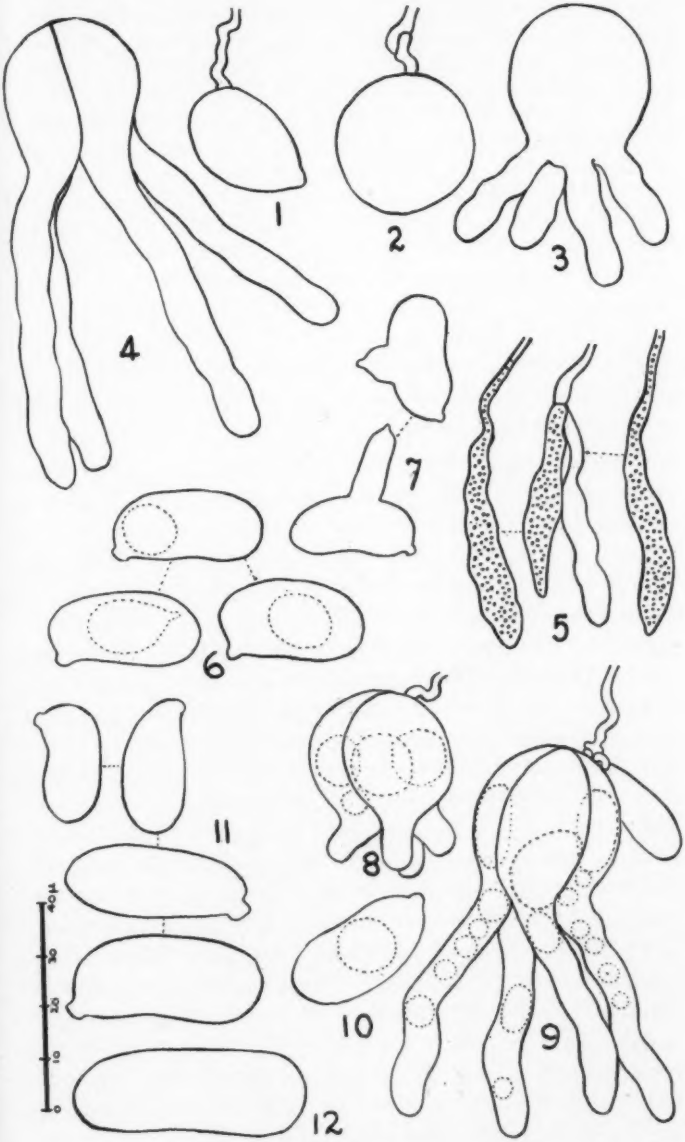

FIG. 1. *Sebacina megaspora.*

frequent clamp connections, immersed in a uniform gelatinous matrix; gloeocystidia abundant, at first hyaline, then yellow and filled with granular material, subcylindrical or clavate, tortuous, relatively small, mostly 30–60 × 6.5–7.5 μ, and restricted to the dense brown surface layer above the probasidia; probasidia at first broadly ovate, then spherical, born on slender tortuous branches and soon detached, 18–28 μ in diameter, finally longitudinally septate into 2–4 cells, each of which produces an epibasidium 50–90 (–150) × 4.5–7 μ; spores hyaline, cylindrical, depressed on one side, or suballantoid, with a conspicuous, blunt apiculus, 24–30 (–38) × 11–14 (–16) μ, germinating by repetition.

Specimens examined:

South Australia: National Park, July 28, 1923, J. B. Cleland 43. **type** (in herb. State Univ. Iowa); Mt. Lofty, June 18, 1932, J. B. Cleland 39; June 13, 1925, J. B. Cleland 24.

Represented by three collections, from two localities. Strikingly different from all other species of the subgenus by reason of its extremely large basidia and spores. A few spore-like bodies without apiculi were seen whose size was considerably greater than that of the largest clearly defined spores. These bodies appeared to belong with the fungus, but their exact nature could not be determined. One such, measuring 45 × 17 μ, is shown in figure 1:12. The apiculus of the spore is unusually large, even for a tremellaceous fungus. It is to be expected that a basidium of average size, divided into only two cells, would produce larger spores than one divided into four cells, and since such basidia are common, they probably account for the larger of the spores seen, while some of the smaller spores may be the result of successive germinations by repetition. A few very small basidia were seen which had divided into two cells, the septum being in most cases nearly or quite transverse. No such small basidia were seen which had produced epibasidia. In general, the probasidia become divided before the epibasidia begin to develop, but some basidia were observed with the epibasidia well advanced and no trace of the longitudinal walls (FIG. 1:3). The hyphae upon which the basidia are borne are curiously slender, and the basidia frequently appear to be completely detached from them, this circumstance having no perceptible effect upon their development.

SEISMOSARCA HYDROPHORA Cooke (FIG. 2: 1–3).

Represented by seven collections. Cooke's original description (Grevillea **18**: 25. 1889) is both inadequate and incorrect, as noted by Lloyd (Myc. Notes **5**: 629. 1917; see also Letter 62, Note 431. 1916). Cooke mistook *Peniophora*-like spores sprinkled on the fungus for the spores of his *Seismosarca*. Lloyd found a similar spore on one of his specimens, also received from Dr. Cleland, and one of the seven collections here discussed had a large number of such spores sprinkled on it. Nevertheless they were certainly not produced by the *Seismosarca*. The true spores of the latter fungus are present in abundance in all the collections. They are hyaline, not pale yellow as Lloyd states, oval or short cylindrical, only rarely slightly allantoid, and 12–15 × 6.5–8.5 μ, germinating by repetition. Since the microscopic structures of the species have never been illustrated, I include camera lucida sketches of basidia, basidiospores and gloeocystidia.

This species raises again the perplexing question of generic limitations in the Tremellaceae. The common American species *Seismosarca alba* Lloyd is certainly congeneric with the Australian species. Burt (Ann. Mo. Bot. Garden **8**: 366. 1921) transferred the American species to *Exidia* with the comment: "it seems unnecessary and a great pity to segregate already small genera on the basis of every positive character which would make a species noteworthy." This is sound taxonomic doctrine. If *Seismosarca alba* were the only species in the genus, the fact that it has gloeocystidia, even added to the fact that its spores are not quite those of an *Exidia* and its texture is decidedly different, might be regarded as scarcely justifying its maintenance in a separate genus. The existence of the obviously closely related *S. hydrophora*, however, complicates the situation, since that species shows many points of similarity to certain species included in the subgenus *Bourdotia* of *Sebacina*, particularly *S. Pululahuana*, from which it is separated mainly by its lobed or somewhat cerebriform habit. In both species here referred to *Seismosarca* the basidiospores germinate by repetition, which is not an *Exidia* character, nor is the surface layer of thick-walled, interlacing hyphae present, noted by Wheldon (Mycologia **27**: 54. 1935) as characteristic for *Exidia*. Under

the circumstances it seems desirable to maintain the genus *Seismosarca* as a useful, if perhaps temporary category. Although Lloyd pointed out Cooke's errors, he failed to publish a revised diagnosis of the genus. I therefore suggested an emended diagnosis which Dr. Cleland published under my name in the work cited (p. 331). *S. hydrophora* must, of course, be the type.

SIROBASIDIUM SANGUINEUM Lag. & Pat. (FIG. 2: 4–7).

Originally described from Ecuador in 1892 (Jour. Bot. **6**: 467) this species has since been reported from North Carolina by Coker (Jour. Elisha Mitchell Soc. **43**: 233. 1928). So far as I am aware, these are the only previous reports of this interesting and distinctive fungus. The other species of the genus are equally rare. *S. Brefeldianum* Möller is known only from Brazil and *S. magnum* Bodijn has recently been described from Borneo and Java. *S. Cerasi* Bourd. & Galz., reported from France, is to be excluded since Bodijn (Bull. Jard. Buitenzorg III. **13**: 268. 1934), after examination of type material, finds that it is not only not a *Sirobasidium,* but that it is perhaps not even a Basidiomycete. In view of the rarity and scattered distribution of the genus, it was of unusual interest to find two collections of *S. sanguineum* in the Australian material, both from Mt. Lofty, South Australia.

In the original publication, Lagerheim and Patouillard describe the fructification as blood red, 4–20 mm. long; the basidia borne in short chains of two to four, separating readily, 18–20 × 10–12 μ, and becoming divided into four cells by longitudinal or oblique septa, each division bearing directly, without a "sterigma," an elongated fusoid spore 17–20 × 6–8 μ. Coker notes that the color is at first pale, later changing to terra cotta, red or cranberry and gives the size of the fructification as 3–20 mm. broad and 1–5 mm. thick. He describes the basidia as reddish brown, mostly pear-shaped, up to 22 μ long and mostly 12–15 μ in diameter, irregularly divided into four cells; the spores as subelliptic, pointed and bent at one end, mostly 15–23 × 5.5–7.7 μ, germinating in yeast-like fashion.

Dr. Cleland notes that his No. 40, when collected, consisted of "gelatinous opaque cerebriform masses, pallid to light ochraceous

buff," which is a good description of its appearance when soaked. Of the other collection, No. 41, he says: "gelatinous, somewhat cerebriform . . . whitish, like chewed bread, becoming tinted sometimes with coral or reddish brown, ½ to 1½ inches long, raised." This specimen, when soaked, became salmon to salmon buff of Ridgway. It will be noted that the maximum size given is nearly twice that given in the earlier accounts cited. No. 40 is obviously an older fructification than No. 41 and its pallid appearance may well be due to the fact that the color has been washed out, as not infrequently happens in the case of tremellaceous fungi with red or yellow tints.

Coker's excellent description and illustrations leave little to be added. Clamp connections are often very conspicuous at the bases of the basidia. Spores borne on the lower basidia, hence deeply immersed in the gelatinous matrix, are long and narrow, 22–26 × 5–7 μ, while those borne at the surface are shorter and broader, 14–17 × 7–9 μ. They germinate by repetition. None were observed which were budding. It is not, of course, unlikely that they may bud under some conditions. The rarity of the species justifies the reproduction of camera lucida drawings illustrating the microscopic structures.

HETEROTEXTUS FLAVUS Lloyd (FIG. 2: 8–11).

A fine collection, determined by Dr. Cleland, shows well the reflexed habit emphasized by Lloyd and brought out in his photographs (Myc. Notes **7**: f. *2231* and *3124*). In his original description (l. c. p. 1151. 1922) Lloyd gives the spore size as 20 × 8 μ and says merely that the spores are septate in germination. In a later reference (l. c. p. 1340. 1925) he gives the spore dimensions as 20–24 × 8–10 μ and says they are 7-septate. In Dr. Cleland's specimen the spores are 14–17 × 6.5–7.5 μ. The septa are rather difficult to see under the dry lens, but under oil immersion they are plain. They vary from three to five, mostly five. None were seen more than 5-septate. There is usually one large guttule in each cell but this may be replaced by two or three smaller ones. In addition to the spores, there were numerous elongated or allantoid conidia in the mounts, apparently borne by

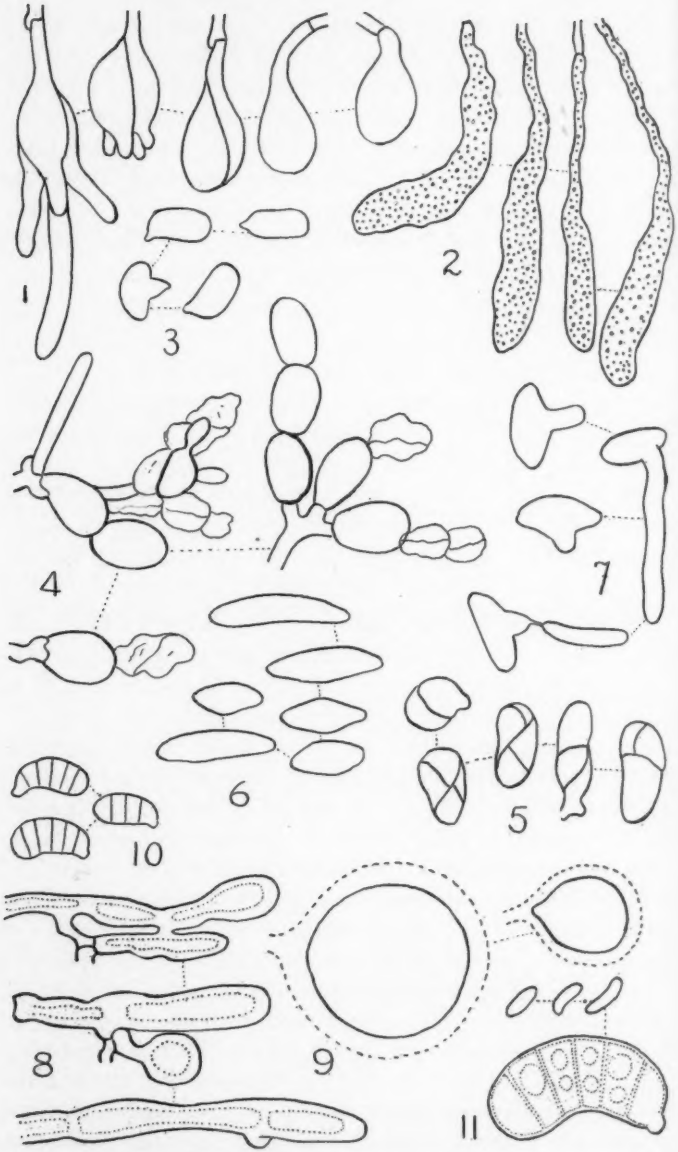

FIG. 2. 1–3, *Seismosarca hydrophora;* 4–7, *Sirobasidium sanguineum;* 8–11, *Heterotextus flavus.*

the spores in germination. The inflated peridial cells are blunter than those of *H. alpinus;* more like those of the congeneric species known as *Guepinia Peziza* Tul. (*Guepiniopsis Peziza* Pat.) although much larger (See Mycologia **24**; pl. 5. 1932). In certain sections, areas appeared in which what seemed once to have been portions of the peridium had been invaginated. In such areas there were numerous large vesicular cells with gelatinous outer walls (FIG. 2: 9) which may have developed from the peridial cells.

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EXPLANATION OF FIGURES

All figures drawn with aid of camera lucida. Fig. 2: 11, drawn at a magnification of × 2436 and reduced in reproduction approximately to × 1755; all other figures drawn at a magnification of × 1110 and reproduced at approximately × 800.

Fig. 1. *Sebacina megaspora.* 1, young probasidium; 2, nearly mature probasidium; 3, detached basidium with developing epibasidia, hypobasidium still unseptate; 4, detached basidium nearly ready to produce spores; 5, gloeocystidia, one still hyaline, three filled with yellow granules; 6, basidiospores; 7, two basidiospores preparing to germinate by repetition; 8, attached septate basidium, the epibasidia very short; 9, nearly mature and highly vacuolate basidium, still attached, and with a young probasidium at base; 10–11, spores; 12, large spore-like body without apiculus. Fig. 1–7 drawn from Cleland 43 (Type); 8–10 from Cleland 39; 11–12 from Cleland 24.

Fig. 2. *Seismosarca hydrophora,* 1–3. 1, basidia in various stages of development; 2, gloeocystidia; 3, spores, one preparing to germinate by repetition. *Sirobasidium sanguineum,* 4–7. 4, groups of basidia; 5, isolated basidia showing variation in septation; 6, spores, showing variation in size and shape; 7, germinating spores, one certainly, two others probably germinating by repetition. *Heterotextus flavus,* 8–11. 8, peridial cells; note anastomosis in uppermost; 9, large vesiculose bodies with gelatinous walls, from invaginated margin; 10, basidiospores; 11, basidiospore and three conidia, × 1755.

NYCTALIS PARASITICA AND N. ASTEROPHORA IN CULTURE[1]

G. E. THOMPSON[2]

(WITH 21 FIGURES)

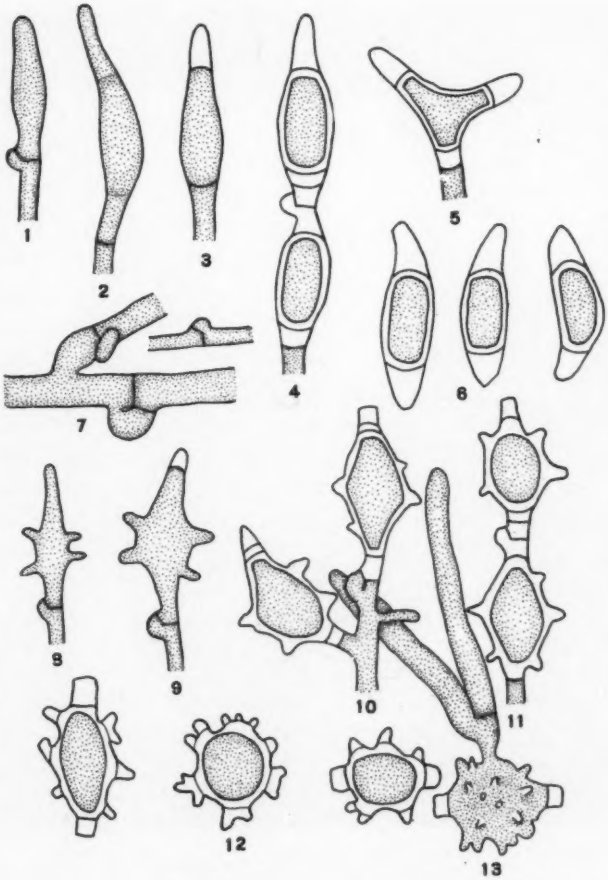
The genus *Nyctalis* in North America contains two species, *Nyctalis parasitica* (Bull.) Fries and *N. asterophora* Fries. The former is especially interesting since its occurrence in North America has been reported on only a few occasions. Overholts (**1930, 1933**) reports its collection on *Russula* in Jefferson County, Pennsylvania. It had been collected previously by Atkinson in 1917 near Seventh Lake in the Adirondack Mountains, notes and photographs being preserved in his herbarium. In Seymour's Host Index it is listed as occurring on *Russula foetens*. These appear to be the only records of its collection in North America.

The other member of this genus, *N. asterophora*, is a more common species, yet of sufficient rarity to cause unusual interest whenever it is found. It appears to have been collected first in North America by Peck (**1872**) at Poughkeepsie, New York. Its occurrence in North America has also been reported by Lloyd (**1901**), Hard (**1908**), Murrill (**1914**), Kauffman (**1918**), Coker (**1919**), and Overholts (**1933**). It has been collected no doubt by others throughout the continent. The following genera of the Agaricaceae have been reported as its hosts: *Cantharellus, Lactarius, Russula, Clitocybe,* and *Armillaria*. The literature dealing with the parasitism of these two species of *Nyctalis* and with the earlier culture work of Brefeld is admirably and fully summarized by Buller (**1924**).

During October, 1933, collections of both species were made by

[1] Presented at the meeting of the Mycological Society of America held at Boston, Massachusetts, December 28–30, 1933.

[2] The writer is indebted to Professor H. M. Fitzpatrick for his valuable criticisms and suggestions in the preparation of this paper, and for his generous assistance in the arrangement of the plates.



FIGS. 1–13. *Nyctalis parasitica* and *N. asterophora* in culture.

the writer near Ithaca, New York, on decomposing fruit bodies of unidentified species of the Agaricaceae, and with little effort both were obtained in pure culture on malt agar in petri dishes. In the isolation of *N. asterophora* chlamydospores were dusted over the surface of the agar. In the case of *N. parasitica* plantings of small fruit bodies were made. From the resulting mycelial

FIGS. 14 and 15. *Nyctalis parasitica* and *N. asterophora* in culture.

growth, transfers were made to test tubes containing the same medium.

Additional media were tried, and it was found that cornmeal, oatmeal, and potato dextrose provide suitable substrata for the growth of *N. parasitica,* while cornmeal and oatmeal are favorable for the growth of *N. asterophora.*

Mature fruit bodies of both species develop within a week, and resemble those found in nature, although there is a tendency for

them to have longer, thinner stalks, and smaller pilei. Chlamydospores wholly like those found in nature are produced in the rudimentary gills of *N. parasitica* and on the surface of the pileus of *N. asterophora.* Chlamydospores similar to those formed in the pilei are also produced quite abundantly on superficial and submerged hyphae. They are borne usually in the tips of the branches, but sometimes occur in chains. In *N. parasitica* the wall is smooth, while in *N. asterophora* it is spiny or warty. Clamp connections appear regularly and clearly.

No attempt was made to induce the germination of the chlamydospores, but in a few cases their germination in *N. asterophora* has been observed.

Although basidiospores have been reported for both species, their production apparently is rare. A careful search of fruit bodies, both those occurring in nature and those produced in culture, failed to reveal any spores of this type. Consequently cultures from this source could not be obtained.

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FIGS. 16–21. *Nyctalis parasitica* and *N. asterophora* in culture.

EXPLANATION OF FIGURES 1–21

Figures 17–21 photographed by G. F. Atkinson; all others made for the writer by W. R. Fisher.

Fig. 1–3, stages in the development of chlamydospores of *N. parasitica* on malt agar (× 850); 4–6, mature chlamydospores of *N. parasitica* (× 850); 7, clamp connections produced on the mycelium in culture (× 850); 8–11, stages in the development of chlamydospores of *N. asterophora* (× 850); 12, mature chlamydospores of *N. asterophora* (× 850); 13, germinating chlamydospore of *N. asterophora* (× 850); 14, *N. asterophora* (three tubes to left) and *N. parasitica* (three tubes to right) after 20 days growth on (left to right) potato dextrose, malt, and cornmeal agar respectively (× 0.34); 15, *N. parasitica* (left) and *N. asterophora* (right) after 20 days growth on malt agar (× 0.56); 16, *N. asterophora*, after one week's growth on malt agar (× 0.75); 17, *N. asterophora* on *Lactarius* sp.; 18, *N. asterophora* on *Russula nigricans;* 19, *N. asterophora* on undetermined host; 20, *N. parasitica* on *Russula* sp.; 21, *N. parasitica* on *Russula foetens.*

THE DEVELOPMENT OF THE ASCOCARP OF ACROSPERMUM COMPRESSUM

HELEN BRANDRIFF [1]

(WITH 11 FIGURES)

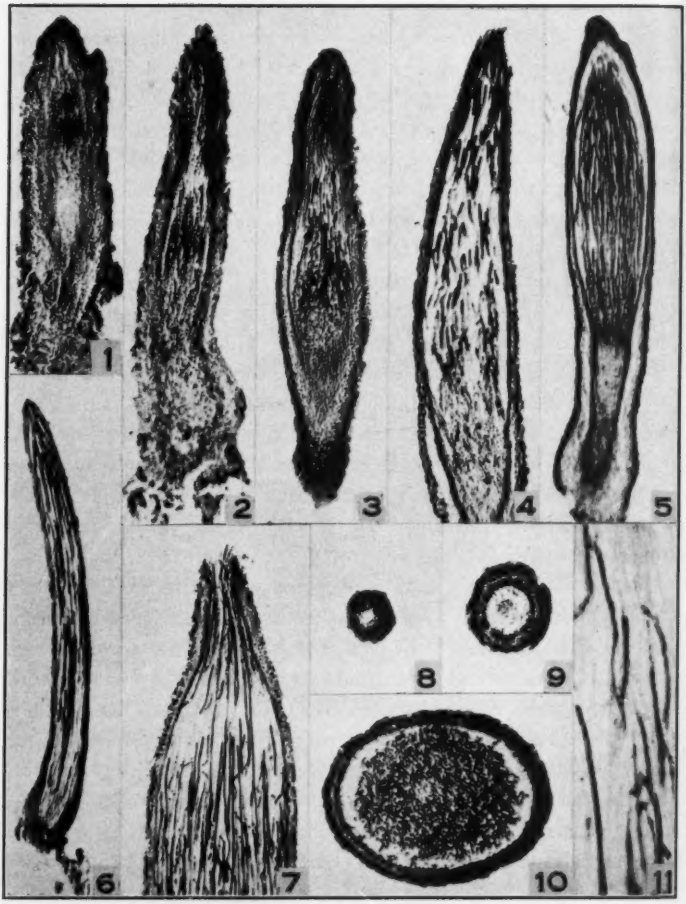
The genus *Acrospermum* was founded by Tode (**1790**) with *A. compressum* as the type species. Rehm (**1887**) considered the genus as one of the Hysteriales. Ellis and Everhart (**1892**) transferred it from that order to the Hypocreales. The family Acrospermaceae was erected for the genus by Lindau (**1896**) who incorporated it tentatively in the Hysteriales. Von Höhnel (**1917**), regarding the fungus as undoubtedly pyrenomycetous, placed it in the Sordariaceae of the Sphaeriales. Riddle (**1920**), who studied the internal structure of the mature ascocarp in stained paraffin sections, concluded that the genus was clearly related to the Hypocreales, it being obviously similar to them in texture and coloration. Clements and Shear (**1931**) follow Ellis and Everhart and Riddle in considering *Acrospermum* as one of the Hypocreales. Arnaud (**1930**) recently added one more taxonomic position for consideration, namely, that of the Caliciées, a discomycetous group treated by him as closely related to the Coryneliales. These several divergent points of view, with the exception of that of Riddle, were based chiefly on the superficial appearance of the fruit-body.

As the taxonomic position of *Acrospermum* is clearly in doubt, and as its possible relationship to the Coryneliales is of interest in connection with researches in progress on that group, the present investigation was suggested by Professor Fitzpatrick. Emphasis has been placed by us upon the nature and origin of the ascocarp wall and ascigerous cavity, the initiation and development of the asci, and the shape and character of the ostiolar opening.

[1] This investigation has been carried on under the direction of Professor H. M. Fitzpatrick, to whom the writer is deeply indebted.

Acrospermum compressum Tode has been reported of common occurrence on a number of herbaceous plants in this country and Europe. Collections in the vicinity of Ithaca, New York, have been made on decaying petioles and leaves of *Caltha palustris,* on culms and blades of grass, and on standing wintered stems of an unidentified herb. Additions to this list obtained from the collections in the herbarium of The New York Botanical Garden comprise *Agrostis perennans, Arctium* sp., *Cinna arundinacea, Elymus canadensis, Impatiens fulva, Lunaria* sp., *Phytolacca* sp., *Urtica dioica, U. gracilis, Verbena* sp., and *Vitis* sp. Though a survey of this list would seem to indicate that the fungus may be collected on many plants, and though considerable effort was expended in searching for it, we found it at only one location in the Lloyd Preserve at McLean, near Ithaca, New York, growing on the overwintered petioles and more rarely on the blades of the leaves of *Caltha palustris,* and on the culms and leaves of nearby grass. Collections were made over a period of two months from the middle of April to the middle of June. Young fruit-bodies were found only with difficulty.

CULTURAL EXPERIMENTS.—An attempt was made to grow the fungus in pure culture in order that immature stages, difficult to locate in the field, might be available for use in the developmental study. Cultures were obtained from mature ascospores. Several ascocarps were attached to the lids of agar plates, and falling spores were caught on the surface of the agar below. The germination of the spores was observed and transfers were made from hyphal tips. Intermingling of hyphae from more than one ascospore occurred in some of the cultures. Growth was slow and in all the plates was essentially identical, being in general rather scant and delicate. After three weeks, fruiting structures developed. These had the appearance of spermagonia or very small pycnidia. They were provided with short beaks, and contained minute unicellular bodies of the aspect of spermatia. These should perhaps be designated as pycnospores, for under suitable conditions they germinated within forty-eight hours, and gave cultures indistinguishable in appearance from those obtained from ascospores. Periodic observations of plants in the field, which had borne ascocarps in the spring, were made throughout the late spring and



FIGS. 1–11. Ascocarp of *Acrospermum compressum*.

summer months up to the first of September in the effort to find an imperfect fruit form in nature, but none was ever seen. The fungus in culture has failed to develop ascocarps, though grown throughout a considerable range of temperature, and on a variety of culture media.

THE MATURE ASCOCARP.—Ascocarps occur singly or in small

groups of two to four. They are superficial, a subiculum, if present, being inconspicuous. The color of the young ascocarp is creamy-white, but at maturity varies from honey-yellow to brown or even brownish-black. In texture the ascocarp is fleshy-cartilaginous to coriaceous, drying horny. The mature fruit-body in shape is elongate-clavate to subcylindric, sessile or subsessile, may reach a length of 3 mm., and at complete maturity is usually compressed laterally. Dehiscence takes place by means of a small circular pseudo-ostiolum (FIG. 8), which may appear elliptical in dried specimens.

The asci are filiform, 300–400 $\mu \times$ 4–5 μ, 8 spored, and surrounded by numerous thread-like paraphyses longer than the asci (FIG. 3, 11). The ascospores are filiform, probably non-septate, nearly as long as the ascus, and entirely fill it (FIG. 11). They are freed by deliquescence of the ascus wall and can be seen protruding through the ostiolar opening as fine threads (FIG. 7).

The mature ascocarp in different collections exhibits considerable variation in shape, size, and color. Fruit-bodies growing on the culms of grass appear to be characteristically shorter, more blunt at the tip, and attached to the substratum by a stouter base. They are brownish-black to black from an early stage and show less indication of darkening from the base upward with maturity than in more typical forms. This variation in size and color was probably the basis for recognition of the species *Acrospermum graminum* Libert, later reduced to a variety by Rehm. The fact that we have observed the two types on the same plant, one on the culms of grass, the other on its leaves, and in the same vicinity as the typical form on *Caltha palustris* has led us to assume that but one species is involved, *i.e., Acrospermum compressum.* Proof of this assumption by inoculation studies was not undertaken.

DEVELOPMENT OF THE ASCOCARP.—At its earliest stage the ascocarp is merely a protruding lobe of homogeneous, pseudoparenchymatous, stromatic tissue. In section it reveals neither cavity nor specialized sexual elements. As it undergoes further development and pushes upward to assume the typical columnar form, the hyphae composing its interior become much elongated in the vertical direction and are narrow and only slightly branching (FIG. 1). These hyphae soon undergo disintegration, and the ascigerous

cavity or locule begins to make its appearance. As the stromatal hyphae disappear the interior of the young ascocarp comes to be filled with ascogenous hyphae (FIG. 2) and later with paraphyses and asci (FIG. 3, 4). From the preparations obtained it is impossible to determine the exact point of origin of the ascogenous hyphae or to distinguish clearly between ascogenous hyphae and young asci except by their positions relative to the developing activity. The paraphyses form more rapidly and are the first to reach the tip of the fruit-body, the young asci in turn pushing up through them (FIG. 3). Bordering the cavity in some preparations a deeper staining layer of hyphae gives somewhat the aspect of a perithecial wall lying within less deeply staining stromatic tissue (FIG. 3–5). The fact that this apparent wall is diffused and loses its identity at the base of the fruit-body (FIG. 3) and is absent in the early stages of cavity formation (FIG. 1, 2), indicates that it is not a true perithecial wall. Moreover, in some cases it is present on one side of the ascigerous cavity (FIG. 3) while wholly absent on the other. These facts lead us to conclude that this apparent wall is in fact merely a zone of stromatal tissue which is more compact and deeply staining than surrounding tissue. In general there can be said to be a loose layer of tissue (FIG. 10) lying between this zone and the firmer peripheral layer constituting the outer surface of the ascocarp. According to the point of view of Miller (**1928**) who has contributed to a clearer understanding of the development of the wall of the Pyrenomycetes, the true perithecial wall originates directly from the coiled archicarp. In our preparations an archicarp was not observed at any stage, and such a true perithecial wall is certainly absent.

The mature ascocarp in longitudinal section usually shows a conspicuous basal region of homogeneous tissue lying beneath the ascigerous locule (FIG. 5). In some ascocarps this is relatively limited in extent (FIG. 6). In no case does it reach the height of development attributed to it by Arnaud, who places *Acrospermum* in the Caliciées and describes the fruit-body as a stipitate apothecium. He separates the Caliciées from the Coryneliées largely on the shape of the fruit-body, stating that in the former it is that of a shallow cup, while in the latter it is that of a deep urn. His

inclusion of *Acrospermum* in the Caliciées on this basis seems indefensible.

The asci cannot be said to form a definite palisade layer such as is typical of the discomycetous fungi. They arise over a relatively limited area at the bottom of the locule and in the aggregate constitute a fascicle in which the long sinuous asci converge toward the apical opening.

Dehiscence of the ascocarp occurs by means of a definite circular pore (FIG. 7, 8). In the case of collapsed, dried specimens, which have a distinctly compressed aspect, the pore appears elliptical. Cases of this sort probably account for the opinion of certain authors that the opening is of the nature of a longitudinal slit, thus showing a relationship with the Hysteriales.

Though the apical opening of the ascocarp is a definite pore, it is not the periphysis-bordered ostiolum of the true sphaeriaceous fungi. It is more of the nature of the pseudo-ostiolum formed in dothidiaceous genera.

CONCLUSIONS.—There seems to be no point at which this fungus shows a close relationship to the Hysteriales. The fructification is erect and columnar while those of the Hysteriales are characteristically horizontal and linear. Moreover, in texture it is typically fleshy-cartilaginous when moist and horny when dry, and is usually light-colored when young becoming darker with age, not black and carbonaceous at all stages. Apparently the authors who placed *Acrospermum* among the Hysteriales did so mainly on the basis of their interpretation of the dehiscence as a longitudinal slit. Typical dehiscence in the order Hysteriales occurs along a dorsal suture, a long slit being formed which opens wide enough to expose the ascospores, and results in a condition approaching that of the Pezizales. The pore of *Acrospermum* can hardly be interpreted as similar. The additional point that the asci and paraphyses of *Acrospermum* constitute a fascicle of elements converging toward the ostiole and not forming a definite hymenial layer leaves no reason for placing *Acrospermum* in the Hysteriales.

Criticism of its inclusion in the Hypocreales rests on our interpretation of the fruit-body as a unilocular dothidiaceous stroma. The ascocarp is strikingly similar to that of many species of the Hypocreales in respect to texture and color and in the filiform

character of the spores. The convergence of asci and paraphyses toward the tip of the ascocarp and its dehiscence by a definite apical pore are admittedly pyrenomycetous characters. The sterile tissue at the base of the fruit-body, while typically discomycetous, is also present in some Pyrenomycetes. The decisive point involved is the absence of a true perithecial wall.

Among the dothidiaceous fungi, the Pseudosphaeriales and Coryneliales would seem to approach *Acrospermum* most closely. The columnar shape of its ascocarp affords at least a superficial resemblance to members of the latter order. Dehiscence among the Coryneliales is varied. Fitzpatrick, who treated the order taxonomically, describes the locule as opening wide at maturity exposing the asci. Dehiscence in some species occurs along a suture or line. In others, several radial clefts give the apex of the ascocarp a lobed appearance. In some, as in *Caliciopsis,* a pseudo-ostiolum of variable diameter is formed as in the Pseudosphaeriales. In its superficial habit *Acrospermum* differs from the Coryneliales, the fruit-bodies there being characteristically clustered on an erumpent cushion of stromatic tissue.

Finally, though a definite statement as to the placement of this fungus which has puzzled mycologists for over a century cannot be made, it would seem that the dothidiaceous nature of the species has been demonstrated, and that a relationship to the Coryneliales and Pseudosphaeriales is indicated. Temporarily it may be assigned to a position in the vicinity of these two orders.

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EXPLANATION OF PLATE

Photographs by W. R. Fisher. Fig. 1, columnar stromatic lobe, in longitudinal section, showing early stage of disintegration of hyphae of interior to form the ascigerous locule, × 210; 2, the partially defined locule in longitudinal section showing developing ascogenous hyphae, × 210; 3, young asci growing up through paraphyses, locule showing apparent perithecial wall on one side only, × 180; 4, nearly mature asci converging toward apex of locule, × 180; 5, mature ascocarp in longitudinal section showing deeper staining zone of tissue bordering the locule, × 180; 6, mature ascocarp in longitudinal section showing an unusually long locule and relatively little basal tissue, × 85; 7, longitudinal section of apical portion of ascocarp showing asci and ascospores protruding through pseudo-ostiolum, × 210; 8, transverse section of apical region of ascocarp showing the circular pseudo-ostiolum, × 210; 9, transverse section of subapical region lying a few microns lower than that pictured in preceding figure, × 210; 10, transverse section of median region of same ascocarp as that shown in preceding two figures, × 210; 11, longitudinal section of mature ascocarp, showing paraphyses and asci, the latter containing mature ascospores, × 340.

THE GENUS UNDERWOODIA

HELENE A. NUSSLÉ

(WITH 1 FIGURE)

The genus Underwoodia, consisting of the single species *Underwoodia columnaris* Peck, was founded by Peck (**1890**) on three specimens collected at Kirkville, Onondaga County, New York, in 1889. He dedicated the genus to Professor L. M. Underwood who had called the plants to his attention. The fungus is of exceptional interest on account of its peculiar form and structure. As it is generally regarded as one of the rarest of North American Discomycetes, the recent collection of a specimen at Ithaca, New York, aroused considerable local interest and stimulated the survey of the literature resulting in this paper.[1] The fungus had been collected at Ithaca only once before, thirty-three years earlier, by a strange coincidence on the same day of the month of July.

Fifteen collections of the species are mentioned in the literature. Five others, announced here for the first time, bring the total to twenty. Eight of these were made in New York, six in Michigan, one in Illinois, one in Iowa, and four in Manitoba. Data concerning these collections are assembled in as complete form as possible in the accompanying table. These show that the fungus has been reported from only seven rather widely separated localities during a period of forty-six years. It is possible of course that additional collections have been made of which we have encountered no record. Underwood searched the type locality in six successive years following the original discovery of the fungus, but found there only three additional specimens (**1899**).

The species has been collected as early as May and as late as September. Official figures on rainfall for the years in which the fungus has been observed, would seem to indicate a correlation with periods of excessive precipitation. Double fruit bodies have

[1] The writer wishes to acknowledge her indebtedness to Professor H. M. Fitzpatrick, who suggested the publication of this paper and supervised its preparation.

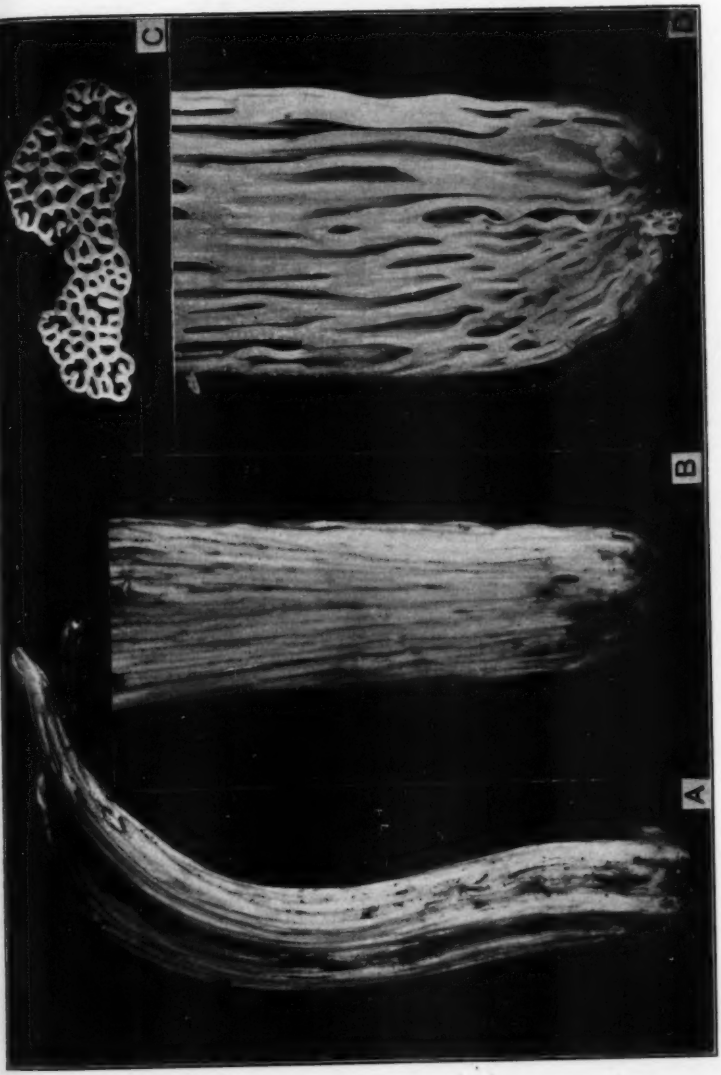

FIG. 1. *Underwoodia columnaris.*

Collection	Collector	Place	Number of Individuals	Present Location of Specimens	Date of Collection	Place of Publication
1	J. T. Fischer	Kirkville, N. Y.	3	N. Y. State Museum, Albany N. Y. Bot. Garden	July, 1889	N. Y. State Museum Rept. **43**: 78, *pl. 4.* 1890.
2	L. M. Underwood	" "	1	" " "	June, 1890	Mycologia **10**: 1–3, *pl. 1.* 1918.
3	" "	" "	1	" " "	June, 1893	
4	E. T. Harper	Neebish Is., Mich.	"cluster"	Field Museum, Chicago	August, 1897	Torrey Bot. Club Bull. **45**: 77–86, *pl. 1–3.* 1918.
5	" "	Mackinac Is., Mich.		" " "	Summer, 1898	
6	" "	Neebish Is., Mich.		" " "	September, 1898	
7	" "	" " "		" " "	September, 1898	
8	" "	" " "		" " "	September, 1898	
9	C. O. Smith	Ithaca, N. Y.	1	Cornell Univ.	July 10, 1902	Present paper.
10	E. T. Harper	Neebish Is., Mich.	1	Field Museum, Chicago	Summer, 1907	Torrey Bot. Club Bull. **45**: 77–86, *pl. 1–3.* 1918.
11	" "	Bureau Junction, Ill.	2	" " "	May, 1908	

Collection	Collector	Place	Number of Individuals	Present Location of Specimens	Date of Collection	Place of Publication
12	S. H. Burnham	Tripoli, N. Y.	1	N. Y. Bot. Garden	July 15, 1917	Mycologia **10**: 1–3, *pl. 1*. 1918.
13	" "	" "	1	" " "	July 22, 1917	
14	" "	" "	1	Cornell Univ.	July 20, 1919	Present paper.
15	G. R. Bisby	Winnipeg, Man.	2	Manitoba Agr. College	July 13, 1927	Bisby, Buller, and Dearness, Fungi of Manitoba, pp. 30, 58. 1929.
16	" "	" "	3	" " "	July 28, 1928	
17	" "	" "	"several"	" " "	August 1, 1928	
18	" "	" "	"	" " "	July 10–11, 1933	
19	G. W. Martin and H. C. Gilbert	Estherville, Iowa	"	Univ. of Iowa	July, 1933	Present paper.
20	Chas. A. Taylor	Ithaca, N. Y.	1	Cornell Univ.	July 10, 1935	Present paper.

been found more often than would have been expected. Such individuals have been figured by Seaver (**1918**: **1928**), and Harper (**1918**), and the recently collected Ithaca specimen is of that type (FIG. A). Harper, in his description of the fungus (**1918**) gives the length of the fruit body as ranging from 5 to 35 cm. The specimen collected at Tripoli, N. Y., in 1919 and reported here for the first time must have exceeded this maximum figure appreciably, since in its present dry state it measures 36 cm.

The Ithaca specimen measured 6 cm. in diameter and 30 cm. in length. It was light buff in color and emitted a strong and characteristic odor. In the grooved appearance of its surface (FIG. B), the chambered aspect of its interior (FIG. C, D), and the size and shape of its spores it agrees with descriptions of previously collected individuals. Attempts to induce spore germination, as well as efforts to get the fungus in pure culture from tissue plantings have been unsuccessful.

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EXPLANATION OF FIGURE

Underwoodia columnaris Peck. Fig. 1. A, double fruit body characteristically curved and tapering; B, surface of basal portion of fruit body showing characteristic grooved appearance; C, transverse section of fruit body cut midway between base and apex; D, longitudinal median section of base of fruit body showing tubular chambers.

A NEW SPECIES OF STYLOPAGE PREYING ON NEMATODES

CHARLES DRECHSLER

(WITH 1 FIGURE)

In Zopf's (**11**) account of the capture of nematodes by *Arthrobotrys oligospora* Fres. and *Monosporidium repens* Zopf were described, apparently for the first time, instances of a biological habit comparable in part to the carnivorous habit of insectivorous flowering plants. More recently (**1, 2, 3**) nearly a score of additional fungi occurring in soil, in leaf mold, and in solid decaying materials generally, have been found to capture and consume nematodes in large numbers; evidently, indeed, subsisting in nature entirely through such predacious activity. By far most of these fungi are closely related to those dealt with by Zopf, being referable to a group of interrelated genera including *Arthrobotrys, Trichothecium, Cephalothecium, Dactylaria, Dactylella* and *Monacrosporium* (**4**). The relatively few nematode-capturing forms alien to this hyphomycetous series are conidial phycomycetes belonging to the Zoopagaceae, a family whose known members are mostly destructive to terricolous amoebae, some operating in parasitic, others in predacious relationships (**5, 6**). Of the few species preying on nematodes, only one, *Stylopage hadra* Drechsl., has hitherto been described in detail (**7**); so that the description offered herein, of a second species of like biological habit, may be of interest even in the absence of pronounced departures in morphology.

The fungus in question was obtained in quantity from several samples of soil collected by F. L. Wellman in celery fields near Sanford, Florida, January 1935. Pinches of the soil were placed on old maizemeal-agar plate cultures liberally infested with nematodes representing species of *Rhabditis, Cephalobus* and *Acrobeles*. After a period varying usually from 1 to 3 weeks, vegetative mycelium was found present here and there in fairly extensive tracts. In general character this mycelium resembled that of *Stylopage*

hadra; the hyphae, filled with densely granular protoplasm, following rather straightforward courses to give off branches at moderate or longish intervals, mostly at wide angles. Evacuation of the older filaments was found frequent, the retreat of the protoplasm being accomplished in stages and thus resulting, as in many other phycomycetes, in the laying down of a succession of cross-walls (FIG. 1, *H*). As the hyphae were consistently narrower than those of *S. hadra,* scarcely measuring two-thirds as much in width, the mycelium had a noticeably more graceful, less staring appearance.

Capture of nematodes was brought about by adhesion to living mycelial filaments provided with deposits of a yellowish sticky substance (FIG. 1, *A–C*). Commensurate with the smaller width of hyphae in the present species, the animals caught and held on them were, on the whole, smaller than those destroyed by *Stylopage hadra;* the eelworms captured measuring ordinarily less than .2 mm., and rarely more than .25 mm. in length. Globose protuberances like those formed on filaments of *S. hadra,* presumably serving to increase the areas of adhesive contact, have never been observed here; their absence probably accounting in part for an apparent inacapacity to hold larger and more vigorous prey. As far as could be determined the death of a captured animal was never hastened through any special development such as is represented among the predacious Hyphomycetes in the intrusion of a bulbous outgrowth, or in the closing of a constricting loop. Consequently the struggles of the hapless eelworm to free itself were continued for a relatively long period. When the ineffectual writhing had become feeble through exhaustion, the integument of the animal was perforated and hyphae thrust inside, where the progress of their elongation was promtply marked by readily visible degeneration of organs and masculature. Death appeared to ensue about at the time the internal hyphae had extended themselves nearly the entire length of the nematode. These internal hyphae were approximately of the same width as the generality of external hyphae. On depletion of the fleshy substance of the prey, the protoplasmic contents were gradually withdrawn back into the parent filament. Thus in the end, only the empty collapsed integument adhering to a local irregularity in the filament remained behind as visible evidence of the animal's fate.

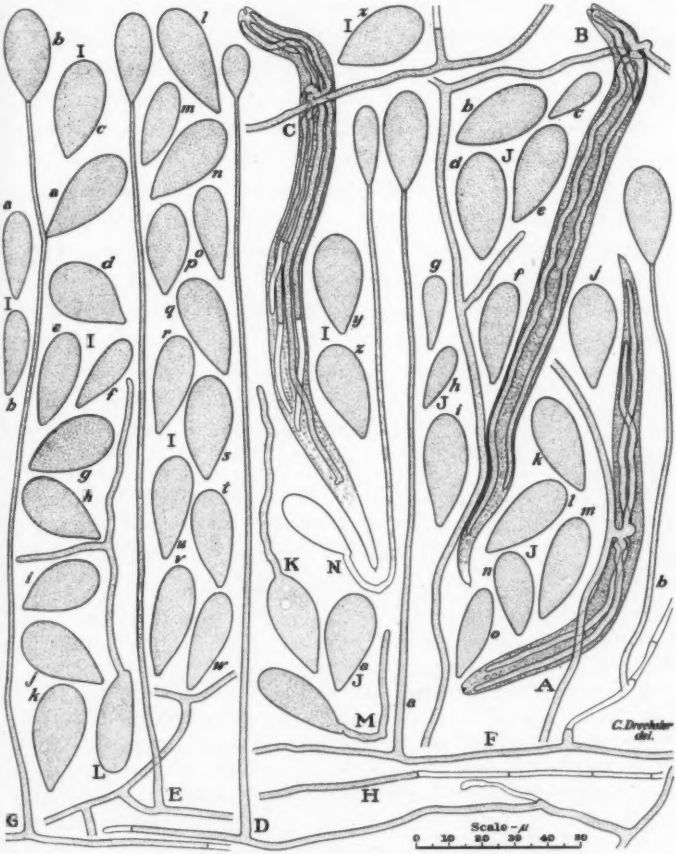

FIG. 1. *Stylopage leiohypha.*

The scattered conidiophores of the Florida fungus (FIG. 1, *D; E; F, a, b; G*) closely resemble those of *Stylopage hadra* in manner of origin and in general habit; but differ from them in having smaller dimensions. Owing to the rather wide variation in height of the fertile hyphae, the differnece in stature between the two species is not especially striking; but the difference in width of the conidiophores, which is more constant as well as proportionally more pronounced, readily distinguishes the slenderer from the

sturdier form. As might be expected, the narrower conidiophores produce the smaller conidia (FIG. 1, *I, a–z; J, a–o*); measurements of 50 spores of the Florida fungus selected at random giving computed averages of 29.3 μ and 12.8 μ for length and width respectively, as compared with averages for the corresponding dimensions in *S. hadra* of 34.6 μ and 17.3 μ respectively. In size, therefore, the southern form is intermediate between *S. hadra* and *S. araea* Drechsl. Its resemblance to the latter species, with respect to a feature shared, to be sure, by all the rest of its amoeba-capturing congeners (**6**), may perhaps appropriately be suggested in a term having reference to the absence of globose protuberances in the capture of prey.

Stylopage leiohypha sp. nov.

Sparsa; hyphis sterilibus incoloratis, 2–3 μ crassis, sine tuberibus animalia tenentibus, integumentum perforantibus, hyphas 2–2.5 μ crassas intus evolventibus, carnem exhaurientibus. Hyphae fertiles 125–300 μ, basi 2.5–3.5 μ crassae, sursum attenuatae, apice 1–1.4 μ crassae, unicum conidium vel interdum usque 3–4 conidia post incrementa repetita ferentes; conidiis incoloratis, obovoideis vel elongato-obovoideis, 20–35 μ longis, 7–18 μ latis. Zygosporae ignotae.

Habitat in terra, nematoda diversa usque .25 mm. longa capiens et consumens, prope Sanford, Florida.

Sparse; vegetative hyphae colorless, 2 to 3 μ wide, capturing nematodes without the production of orbicular protuberances, perforating the integument of each animal, then giving rise inside to haustorial hyphae, 2 to 2.5 μ wide, which assimilate the fleshy contents. Conidiophores 125 to 300 μ high, 2.5 to 3.5 μ wide at the base, tapering upward, 1 to 1.4 μ wide at the tip, bearing a single conidium, or often producing up to 3 or 4 conidia one by one after repeated elongation. Conidia colorless, obovoid or elongate obovoid, measuring 20 to 35 μ (average 29.3 μ) in length by 7 to 18 μ (average 12.8 μ) in width. Zygospores unknown.

Occurring in soil, capturing and consuming nematodes up to .25 mm. in length belonging to species of *Rhabditis, Cephalobus* and *Acrobeles,* near Sanford, Florida.

The new species contributes little additional information concerning the taxonomic position of the Zoopagaceae. Its conidia germinate usually by a single hypha (FIG. 1, *K, L*), which may originate either from the rounded apex, or from a position immediately adjacent to the slightly flattened basal hilum. Often

the germ tube after growing some distance horizontally on the substratum, changes its direction (FIG. 1, *M*) and continues growth vertically into the air as a conidiophore to produce terminally a secondary conidium (FIG. 1, *N*). Apparently the same process may be repeated to give rise to a tertiary conidium. This repetitional development, as was pointed out in the discussion (**7**) of *Stylophage hadra,* recalls the behavior frequent with conidia of various species of *Empusa,* and thus provides one of the few indications of relationship to the Entomophthorales. These indications direct attention also to the possibility of relationship with other conidial zygomycetes made known in recent years; such, for example, as the Harpellaceae, a family of singular fungi that Léger and Duboscq (**8**) and Léger and Gauthier (**9**, **10**) have briefly described from the digestive tube and rectal cuticle in the aquatic larvae of various insects. The presence of curious evanescent spiral basal appendages on the conidia of the Harpellaceae, and the biconic shape of the zygospore in the forms wherein the sexual stage has been observed, constitute morphological features no less alien to the Zoopagaceae than to the older established groups in the Entomophthorales. Nevertheless, provoking analogies would seem present, which, if supplemented through the discovery of additional types, may well lead not only to an appropriate orientation of the newer groups, but also to a more satisfactory ordering of the old.

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EXPLANATION OF FIGURE

Fig. 1. *Stylopage leiohypha;* drawn with aid of camera lucida at a uniform magnification; × 500 throughout. *A–C,* Portions of hypha on each of which has been captured a nematode (referable probably to *Cephalobus* sp.), showing haustorial filaments, disorganization of animal's fleshy parts, and in *C,* early stage in evacuation of haustorial filaments. *D,* Conidiophore with young growing conidium. *E; F, a, b;* Conidiophores, each with one fully grown conidium. *G,* Conidiophore with 2 conidia, *a* and *b,* produced successively. *H,* portion of vegetative hypha, partly evacuated, showing 3 septa in empty portion. *I, a-z; J, a-o;* Mature conidia. *K, L,* Conidia germinating vegetatively. *M,* Conidium with a germ tube developing distally into an erect conidiophore. *N,* Conidium with a germ tube that has developed distally into an erect conidiophore bearing a nearly mature secondary conidium.

SOME ASCOMYCETES NEW TO CALIFORNIA

EDITH K. CASH

(WITH 5 FIGURES)

Among recent collections of fungi from Humboldt County, California, made by Mr. H. E. Parks, several seem to be new to that region. Five of these are discomycetes which are apparently undescribed and therefore named as new species, while the sixth is a *Nectriella* not previously reported from North America. Specimens are deposited in the Parks herbarium and in the Mycological Collections of the Bureau of Plant Industry.

1. **Arachnopeziza Arctostaphyli** n. sp. (FIG. 1).

Apothecia sessile on sparse subicle of hyaline mycelium, at first subglobose, becoming patellate, cream-color [1] to light buff when dry, .4–.7 mm. diam., attached at the margin by delicate, hyaline hairs; asci clavate, often arcuate, narrowed abruptly at the apex, attenuated toward the base, 100–115 × 10–12 μ; spores irregularly fasciculate, many-guttulate, straight or curved, 7-septate, 65–80 × 2.5–3 μ; paraphyses filiform, branched about half-way from the base, non-septate, granular, hyaline; exciple prosenchymatic, hyaline, with septate hairs at the margin, 100–120 × 4–6 μ, occasionally bearing crystals up to 13 μ in diam.

Apotheciis in mycelio tenui hyalino sessilibus, subglobosis demum patellatis, cremeis vel pallidis, .4–.7 mm. diam.; ascis clavatis, saepe arcuatis, 100–115 × 10–13 μ, apice acute attenuatis; sporis irregulariter fasciculatis, multiguttulatis, 7-septatis, rectis curvulisve, 65–80 × 2.5–3 μ; paraphysibus filiformibus, ramosis, granulosis, hyalinis; margine setis hyalinis, septatis, 100–120 μ longis, 4–6 μ latis, ornata.

On decorticated stems of *Arctostaphylos Tracyi,* Spruce Cove, Trinidad, Calif., H. E. Parks *5329,* Feb. 16, 1935.

Among species with approximately the same dimensions, *Belonidium pulvinatum* Boud. is gray to purplish, with clavate para-

[1] Color terminology follows that in Ridgway, Color Standards and Color Nomenclature, Washington, 1912.

physes and fifteen-septate spores. *Erinella byssacea* P. Henn. & Nym. from Java seems nearest to the California material. No specimen of this is available for comparison, but it is described as having yellow apothecia and hairs, and paraphyses 3 μ in diameter. *Erinella borealis* Povah, a fungus apparently similar in macroscopic appearance, differs in smaller asci and spores. The filiform paraphyses would prevent this species from falling in the genus *Erinella* and the presence of a thin but widespread and distinct subicle make it a better *Arachnopeziza*.

2. **Belonidium Parksi** n. sp. (FIG. 2).

Apothecia gregarious, cupulate, sessile, exterior fuscous, furfuraceous, hymenium glaucous-green, drying chromium-green, margin inrolled and plicate, hysteroid, triangular, or irregularly folded; asci clavate-cylindrical, abruptly narrowed at the apex, gradually attenuated toward a short stipe, 65–80 $\times$ 6–8 μ; spores fusoid, straight or slightly curved, obliquely uniseriate below to biseriate above, 4-guttulate, becoming 1–3-septate, acute at both ends, 11–17 $\times$ 2–4 μ, usually about 13 $\times$ 3 μ; paraphyses filamentous, septate, unbranched, tips granular and slightly enlarged to 1.5–2 μ in diam.; exciple dark-pseudoparenchymatous, cells 7–12 μ in diam., elongated toward the margin, readily breaking up and giving the exterior of the apothecium its furfuraceous appearance.

Apotheciis gregariis, cupulatis, sessilibus, fusco-furfuraceis, hymenio glauco-virido, siccis margine involuto irregulariter plicatis; ascis clavato-cylindraceis, apice attenuatis, breviter stipitatis, 65–80 $\times$ 6–8 μ; sporis fusoideis, 1–2-seriatis, 1–3-septatis, 11–17 $\times$ 2–4 μ; paraphysibus filamentosis, septatis, apice 1.5–2 μ diam.; textura excipuli parenchymatica, e cellulis brunneis, 7–12 μ diam., marginem versus elongatis, composita.

On decorticated stems of *Vaccinium parvifolium*, Prairie Creek, Humboldt Co., Calif., Mar., 1935, H. E. Parks *5485* (*Type*), *5335*, on *Rhamnus Purshiana*, Feb., 1935, Spruce Cove, Calif.; *5387*, on *Garrya elliptica*, *5413*, on *Physocarpus capitatus*, *5450*, *5455*, on *Castanopsis chrysophylla*, Spruce Cove, March, 1935.

3. **Scleroderris lobata** n. sp. (FIG. 3).

Apothecia coriaceous, subglobose to cupulate, rarely expanded, breaking through the bark singly or in groups of 2–4, opening by splitting at the margin into 4–6 lobes which fold over one another

on drying, up to 1 mm. in diam. and height, externally blackish brown, smooth, drying glossy black, hymenium light olive-gray; asci cylindrical, short stipitate, gradually narrowed toward the base, rounded and slightly narrowed with thickened wall at the apex, 90–115 × 7–9 μ; spores obliquely 1-seriate below, 2-seriate above, clavate, occasionally 2-, but usually 3-septate, the lower end acute, 18–20 × 3–4 μ; paraphyses numerous, filiform, rarely septate, simple or branched near the tip, slightly and abruptly inflated; subhymenial layer ochraceous-tawny to amber-brown, composed of angular cells 5–10 μ in diam., outer layer of elongate hyphae forming a thick-walled prosenchyma.

Apotheciis subglobosis cupulatisve, nigro-brunneis, 1 mm. diam. et altis, glabris, margine lobato, hymenio griseoalbo; ascis cylindraceis, 90–115 × 7–9 μ; sporis 1–2-seriatis, 2–3-septatis, clavatis, 18–20 × 3–4 μ; paraphysibus filiformibus, simplicibus vel furcatis, leniter inflatis.

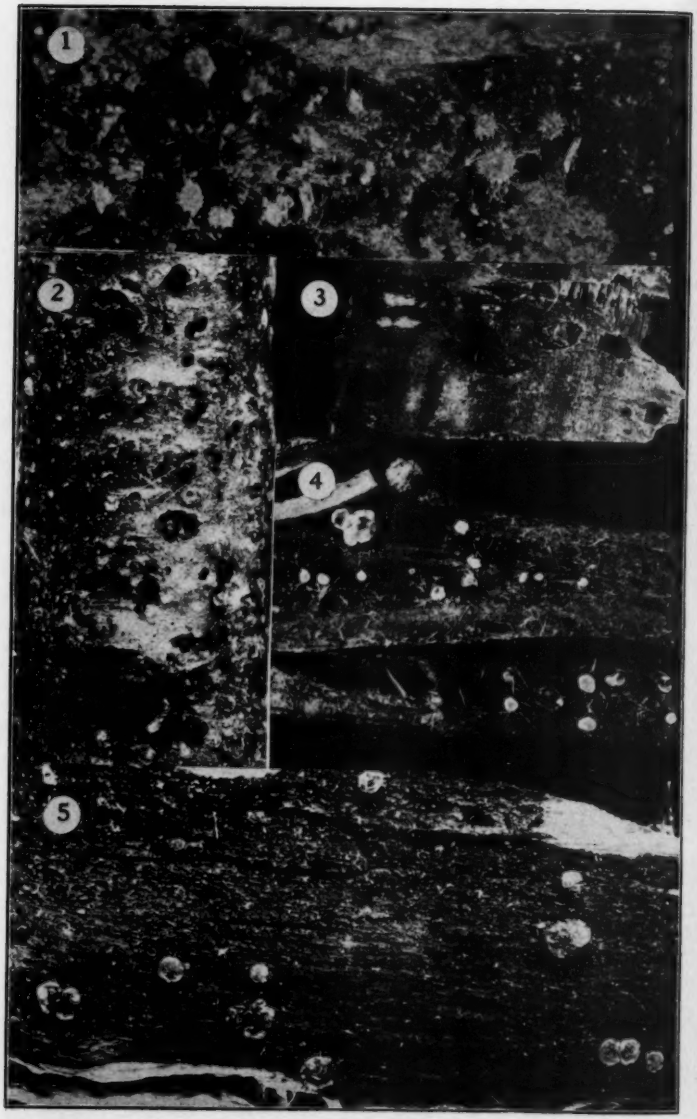
On twigs of *Ribes Menziesii,* Spruce Cove, Trinidad, Calif., March, 1935, H. E. Parks *5472.*

This fungus can be distinguished from *Scleroderris ribesia* (P.) Karst. by the smooth exciple, lobate margin, and shorter spores; the wide overlapping lobes of the margin were not seen in any similar species on *Ribes. Scleroderris tumoricola* Cash found on *Ribes montigenum* in Colorado differs in the furfuraceous exciple, smaller spores, and its habit of growth on canker-like areas of the host.

4. **Helotium cremeum** n. sp. (FIG. 4).

Apothecia firm, waxy, sessile, patellate, occasionally lobate, .5–1 mm. diam., exterior cream white, hymenium cream-color to cream-buff, margin distinct, whitish furfuraceous; asci clavate, long-stipitate, 75–90 × 10–12 μ, narrowed but round at the apex, gradually attenuated toward the base; spores fusoid-clavate, 2-celled, slightly constricted at the septum, 12–15 × 4–5 μ, granular, 1–2-seriate, upper cell slightly wider than the lower, containing many small guttulae; paraphyses filiform, septate, unbranched, 2 μ at the apex; exciple subhyaline, prosenchymatous.

Apotheciis ceraceis, sessilibus, patellatis, cremeis, .5–1 mm. diam., pallide marginatis; ascis clavatis, longe stipitatis, 75–90 × 10–12 μ; sporis fusoideo-clavatis, guttulatis, 1–2-seriatis, 1-septatis, leniter constrictis, 12–15 × 4–5 μ; paraphysibus filamentosis, apice 2 μ; textura excipuli subhyalina, prosenchymatica.



FIGS. 1, *Arachnopeziza Arctostaphyli*; 2, *Belonidium Parksi*; 3, *Scleroderris lobata*; 4, *Helotium cremeum*; 5, *Helotium nitens*.

On stipes of *Pteridium aquilinum pubescens,* Spruce Cove, Trinidad, Calif., H. E. Parks *4149* (*type*) Mar., 1933, and *5514,* April, 1935.

This *Helotium* differs from the species of Helotiaceae reported on ferns (*Pezizella aspidiicola* (Berk. & Br.) Rehm, *P. chrysostigma* (Fries) Sacc., *P. versicolor* (Desm.) Rehm, *Helotium aureolum* Sacc.) in larger asci and broader spores. It seems most closely related to *Helotium separabile* Karst., in which the spores are narrower and the asci smaller, and to *H. Humuli* (Lasch) De Not., a darker colored fungus with longer spores.

5. **Helotium nitens** n. sp. (FIG. 5).

Apothecia fleshy to subgelatinous, sessile, pulvinate, convex, not distinctly margined, gregarious, sometimes confluent, 1–1.5 mm. diam., 1 mm. high, pale yellow-orange to light salmon-orange, hymenium glistening, even, smooth, drying Mars-orange, exterior slightly paler; asci clavate-cylindrical, rounded and with the wall thickened at the apex to 5 μ, gradually attenuated below to a long stipe, 150–170 $\times$ 7–8 μ; spores ellipsoid-clavate, at first unicellular, later 1-septate, 13–18 $\times$ 4–4.5 μ; paraphyses filiform, non-septate, thickly branched near the apex, 1 μ diam., not enlarged; exciple of densely interwoven fine, greenish-yellow hyphae.

Apotheciis carneis, gelatinosis, sessilibus, pulvinatis, 1–1.5 mm. diam., flavo-aurantiis, nitentibus; ascis clavato-cylindraceis, apice rotundatis, deorsum attenuatis, 150–170 $\times$ 7–8 μ sporis ellipsoideis clavatisve, primum simplicibus, demum uniseptatis, 13–18 $\times$ 4–4.5 μ; paraphysibus filiformibus, apice dense ramosis, 1 μ diam.

On wood of *Arctostaphylos Tracyi,* Spruce Cove, Trinidad, Calif., Feb. 16, 1935, H. E. Parks *5330.*

The asci in *H. nitens* are longer and more slender than in *Helotium subtrabinellum* Bres. and the paraphyses are not swollen at the apex as in that species. The glistening hymenium and subgelatinous character are suggestive of *Calloria,* from which, however, the fungus differs in the prosenchymatic exciple and more fleshy consistency.

6. NECTRIELLA SAMBUCI (v. Höhn.) Weese.

Collections determined as this species, apparently not before reported from the United States, were made by Mr. Parks at Spruce Cove, Trinidad, Calif., in March, 1935, on *Sambucus racemosa* (*5417*) and *Lupinus rivularis* (*5481–A*) and in January, 1935, on *Heracleum lanatum* (*5296*). All of this material agrees with Weese's description [2] in dimensions, color, and the occasional presence of hyaline hairs around the margin of the perithecia. Weese's conclusion that *Charonectria Umbelliferarum* v. Höhn. occurring on Umbelliferae is probably identical with the similar species, *Charonectria Sambuci* v. Höhn., described on *Sambucus*, is therefore corroborated by the California collections. The specimen in the Mycological Collections of Rehm Ascomycetes no. 1867 (*Charonectria Umbelliferarum* v. Höhn. on stems of an umbellifer) unfortunately is immature. Another possible synonym suggested by Weese is *Nectriella dacrymycella* (Nyl.) Rehm; European material of this species, issued as Krieger Fungi Saxonici *1719*, on *Cirsium arvense*, agrees with the California specimens, except for the deeper color of the apothecia. Rehm [3] is of the opinion that *Nectria Heraclei* Crouan and *Nectriella Umbelliferarum* (Crouan) Sacc. may also be identical with *Charonectria Umbelliferarum* v. Höhn. Weese points out other possible synonyms, but since type specimens have not been examined, he uses the name given by von Höhnel to the earlier of his two *Charonectria* species. *Nectria Sambuci* Ellis & Ev., an entirely different fungus occurring on *Sambucus*, is one of the many synonyms of *Creonectria purpurea* (L.) Seaver.

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EXPLANATION OF FIGURES

Fig. 1. *Arachnopezisa Arctostaphyli* on *Arctostaphylos Tracyi*, Parks *5329*, × 15; 2, *Belonidium Parksi* on *Castanopsis chrysophylla*, Parks *5455*, × 5; 3, *Scleroderris lobata* on *Ribes Menziesii*, Parks *5472*, × 5; 4, *Helotium cremeum* on *Pteridium aquilinum pubescens*, Parks *5514*, × 5; 5, *Helotium nitens* on *Arctostaphylos Tracyi*, Parks *5530*, × 5. Photographs made by M. L. F. Foubert.

[2] Ann. Myc. **12**: 150. 1914.
[3] Ann. Myc. **7**: 528. 1909.

NEW OR NOTEWORTHY SPECIES OF RUSSULA AND LACTARIA

GERTRUDE S. BURLINGHAM

(WITH 8 FIGURES)

From November 1927 until late January 1928, and again from October 1934 until May 1935, it was my good fortune to collect fungi, especially of the genera *Russula* and *Lactaria,* in the vicinity of Seattle, Washington; Corvallis, Oregon; and in Pacific Grove, California. While much work remains to be done on this material, there are certain outstanding species which deserve immediate publication. I am also including in this article the description of a new species collected in Wyoming by the late Simon Davis, and notes on *Russula Mariae* Peck.

Russula placita sp. nov. (FIG. 1–*A*).

Pileus fleshy, broadly convex then expanding, dark violet to vinaceous in the center, corinthian red to slate violet on the margin, pruinose in dry weather, very slimy viscid when wet, then glabrous, pellicle separable part way to the center, up to 10.5 cm. broad; margin coarsely striate tuberculate; context white except next the pellicle where it varies from corinthian red to slate violet, fragile, acrid, without special odor; lamellae white at first, becoming pale ecru, deepest colored on the edge, equal, mostly simple, ventricose, up to 1.2 cm. broad, narrowed toward the inner end, then rounded and depressed next the stipe and attached by a tooth, close, interveined, pruinose; stipe white but slightly yellowish in drying, spreading at the apex, spongy, 8.5 by 2–2.2 cm.; spores ochroleucous tone 1–2 in mass, broadly elliptical, apiculate, with scattered protuberances, some of which are connected by fine lines or bands, mostly 7.5 $\mu \times$ 8.75 μ.

TYPE LOCALITY: Near Seattle, Washington.

HABITAT: Usually under Douglas fir, but sometimes under pines.

DISTRIBUTION: South Tacoma, Squaw Mountain, and various other places near Seattle, Washington; Corvallis, Oregon; and Pacific Grove, California.

Pileo carnoso, convexo-plano, jove pluvio viscoso, medio vinoso, margine livido, striato-tuberculoso; carne alba, fragili, acri; lamellis pallide gilvis, aequalibus, simplicibus, postice attenuatis sed proxime stipitem rotundatis, confertis; stipite albo, spongioso, 8.5 cm. × 2–2.2 cm.; sporis ochroleucis 7.5 μ × 8.75 μ (FIG. 1–*A*).

This species differs from both *Russula corinthiürubra* Burl. and *Russula atroviolacea* Burl. in its more spongy texture, in the striate tuberculate margin, the band of striations sometimes reaching from 1 to 1.5 cm. in toward the center, in the attachment of the lamellae, and in the paler color and markings of the spores. It is one of the most abundant Russulas in the vicinity of Seattle during October.

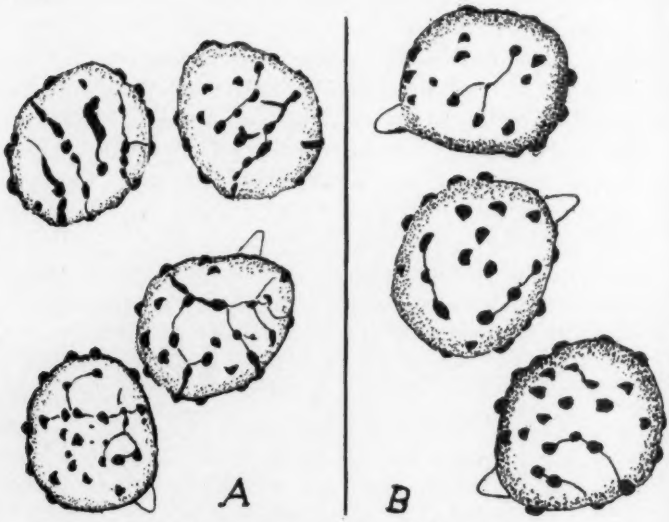

FIG. 1–*A*. Spores of *Russula placita*.
FIG. 1–*B*. Spores of *Russula murina*.

Russula murina sp. nov. (FIG. 1–*B*).

Pileus broadly convex, becoming plane to centrally depressed, up to 7.5 cm. broad; surface light olive gray or deep olive gray in the center, slimy viscid when wet, pruinose when young, glabrous and shining over the marginal area when mature, rarely becoming granulose on the disc, cuticle separable more than half way to the center; margin becoming coarsely striate tuberculate for a width

of 1.5 cm.; context white, mild then slowly slightly acrid, decidedly so in young specimens, fragile; lamellae becoming pale ecru tone 4 to maize yellow tone 2, equal and mostly simple, rounded next the stipe and attached by a tooth, close, rather broad; stipe white, sometimes yellowish at the base, spreading at the apex, otherwise nearly equal, glabrous, 4.5 cm. × 1.3–1.5 cm.; spores yellow ochre (326 t. 2) with large protuberances varying in size, having a few connected by fine lines, 7.5 μ × 10 μ to 7.5 μ × 8.75 μ.

TYPE LOCALITY: Near Agate Beach Inn, Agate Beach, Oregon.

HABITAT: In dirt and needle soil under Douglas fir and lodgepole pine.

DISTRIBUTION: The type locality and Newport, Oregon.

Pileo e convexo expanso depressoque, pruinoso, fragili, jove pluvio pellicula separabili viscosa, tunc demum margine polito, glabro, tuberculoso-striato, infrequenter disco granuloso, murino colore; carne alba, tarde acri; lamellis pallide ochroleucis, confertis, aequalibus, simplicibus; stipite albo, glabro; sporis ochroleucis, 7.5 μ × 8.75 μ–10 μ.

This species belongs in the group with *Russula gracilis* Burl. from which it differs in being less fragile, in the color of the pileus, in its less acrid taste, and in its habitat. In appearance in the field and in dried specimens, the two species are quite different.

Russula inconstans sp. nov. (FIG. 2–*A*).

Pileus broadly convex becoming plane to centrally depressed, from 5.5 cm. to 13 cm. broad; surface corinthian red on the margin toning into pale reddish lilac, mineral brown to maize yellow over the center, or vandyke brown in the center when young, fading with age, slimy viscid when wet, cuticle separable half way to the center, glabrous; margin pruinose when young, becoming striate tuberculate on the edge; context white, unchanging, acrid in young specimens, slowly acrid in the adult stage, without special odor; lamellae white at first, becoming pale ecru tone 4 to maize yellow tone 2, some short, some forking near the stipe or near or part way to the margin, depressed near the stipe and attached by a tooth, close, not very broad; stipe white sometimes with yellow stains at the base, spreading at the apex, firm becoming spongy, 1.5–3.5 cm. × 6–8 cm.; spores ochroleucous, 6.8μ–7.5 μ × 7.5μ–8.75 μ, exclusive of the apiculus, reticulate banded with some protuberances and some fine connecting lines.

TYPE LOCALITY: Woodcock's Hill, Corvallis, Oregon, Nov. 14, 1927.

HABITAT: In needle soil under Douglas fir trees on the edge of woods.

DISTRIBUTION: In various localities near Corvallis, Oregon.

Pileo variegato, firmulo, explanato depressove, jove pluvio viscoso, glabro; margine primum pruinoso, tum glabro, dein striatulo; carne alba, acri; lamellis ex albo gilvis, adnexis, confertis, immixtis brevioribus, furcatis; stipite albo, e firmo spongioso; sporis ochroleucis, reticulatis, 6.8 μ–7.5 μ × 7.5 μ–8.75 μ.

This species differs from *Russula placita* in the narrower forking lamellae, the firmer context, in the deeper yellow spores as well as in the color of the pileus and the less pronounced striate tuberculate margin. From *Russula maculata* Quél. it differs in the paler lamellae and the absence of red or bistre on the stipe, and in having smaller ellipsoid and reticulate banded spores.

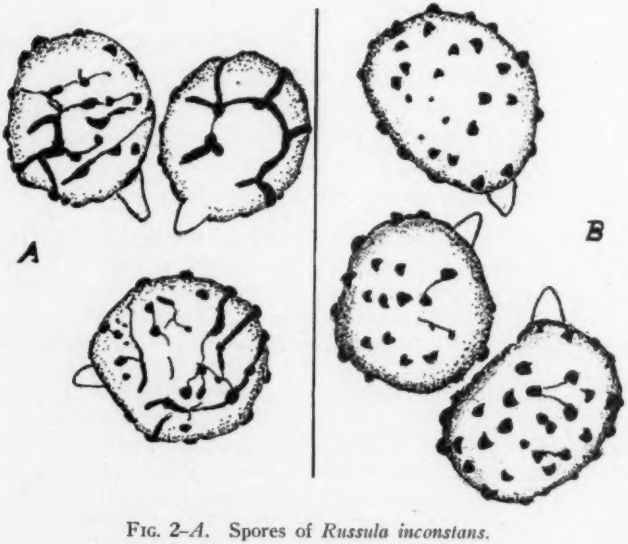

FIG. 2–*A*. Spores of *Russula inconstans*.
FIG. 2–*B*. Spores of *Russula Zellerii*.

Russula Zellerii sp. nov. (FIG. 2–*B*).

Pileus convex becoming plane then somewhat centrally depressed, up to 9 or more cm. broad; surface anthrocene purple to

taupe brown at the center, becoming in mature specimens vinaceous lilac to deep purple vinaceous at the margin and taupe brown [1] at the center, slimy viscid when wet, with separable tough cuticle, glabrous; margin soon striate, becoming coarsely striate tuberculate for 2 cm. toward the center, thin; context white, unchanging, fragile, pleasantly mild; lamellae fleshy white becoming pale ecru tone 2 when mature, equal, a few forking near the margin, venose connected, broad, rather distant, rounded at the outer end, narrowed at the inner end and attached by a line, appearing nearly free; stipe white, unchanging, tapering upwards, glabrous, 1–1.5 cm. by 5–6 cm.; spores maize yellow tone 2, ellipsoid, echinulate, apiculate, unsymmetrical, 7.5–8 $\mu \times$ 8.75–9.3 μ, rarely with a few connecting lines between scattered protuberances of various sizes.

TYPE LOCALITY: Campus of Oregon State College at Corvallis, Oregon. Type No. 7170 in part in the herbarium of the Oregon State College, and in part in the author's herbarium.

HABITAT: On clay soil in grass and moss under *Picea sitchensis*.

Pileo e convexo plano-depresso, viscoso, vinaceo, 9 cm. lato; margine livido demum lilacino, striato; lamellis ex albo pallidis, aequalibus, subliberis, confertis, latis, subdistantibus, antice furcatis; carne alba, miti, fragilissima; stipite albo, glabro, sursum attenuato, 1–1.5 cm. × 5–6 cm.; sporis pallide alutaceis (Repertoire de Couleurs pl. 36 t–2), echinulatis, 7.5–8 $\mu \times$ 8.75–9.3 μ.

This is a beautiful species distinguished by the mild taste, thin flesh of the pileus and the broadly striate margin. It is fragile especially when mature. From *Russula integra* (L.) Fries it differs in its more fragile context, vinaceous color, and in the shape and markings of the spores. From *Russula puellaris* Fries, it differs in its larger size, the absence of yellowish stains on the stipe, the free and more distant lamellae, and the larger ellipsoid spores. The average size of the pileus in adult specimens is about 9 cm., but the extreme size reaches 15 cm. in diameter. The type collection was made on Nov. 28, 1927 by Dr. S. M. Zeller, and another on Dec. 5, 1927. And from the same locality I secured another collection in November.

Russula marginata sp. nov. (FIG. 3–*A*).

Pileus broadly convex becoming expanded and centrally depressed, up to 12 cm. broad; surface sordid white on the center

[1] Ridgeway.

with pinkish-bluish [2] tints on the margin, viscid when wet, pellicle separable on the margin, glabrous; margin even to striatulate, involute; context fleshy, firm, white, instantly acrid, but not persisting, odor unimportant; lamellae white becoming a little ochraceous with age, equal or with a few short ones, many forking, brittle, close, rounded at the outer end, narrowed at the stipe; stipe white, discolored with handling, equal or tapering upwards from below the middle, and abruptly tapering at the base, making it ventricose to subventricose, becoming hollow, up to 3.75 cm. × 6 cm.; spores ochroleucous, ellipsoid, apiculate, with scattered protuberances of varying size, some connected by bands or fine lines, unsymmetrical, 5.6–6.2 μ × 8.75–10 μ.

TYPE LOCALITY: Z/T Ranch, Rock Creek, Wyoming. No. 2 of July 17, 1920, Simon Davis, collector.

HABITAT: Under greasewood, gregarious.

DISTRIBUTION: Several collections from near the type locality.

Pileo convexo-explanato depressoque, disco sordide albo, margine livido, jove udo viscido; margine involuto, levi, dein striatulo; carne alba, firma, acri; lamellis ex albo subochraceis, subaequalibus, furcatis postice attenuatis, confertis; stipite albo, tacto ochroleucescente, aequali ventricosove, e farcto cavo, glabro; sporis ochroleucis, 5.6–6.2 μ × 8.75–10 μ (FIG. 3–*A*).

In dried specimens the color of the margin of the pileus varies from atroviolaceous to bluish lilac and corinthian red, while the center varies from putty color to snuff brown, sometimes with a dull greenish tint, the stipe becomes ochroleucous. This species differs from *Russula atroviolacea* Burl. in being instantly but not lastingly acrid, the marginal band of color surrounding the sordid white center, and the discoloring of the stipe with handling or in drying, while the spores are paler and ellipsoid.

Russula mordax sp. nov. (FIG. 3–*B*).

Pileus broadly convex, expanding and somewhat centrally depressed with drooping margin, up to 13 cm. broad; surface blood-red brown to madder brown, viscid but not slimy when wet, cuticle separable half way to the center, flesh white underneath; margin even; context white, unchanging, without odor, very acrid; lamellae maize yellow tone 1, equal, many forking near the stipe and a few near or part way to the margin, intervened, rounded at the outer end, abruptly narrowed next the stipe, close; stipe washed

[2] According to terminology of Simon Davis; probably lividus.

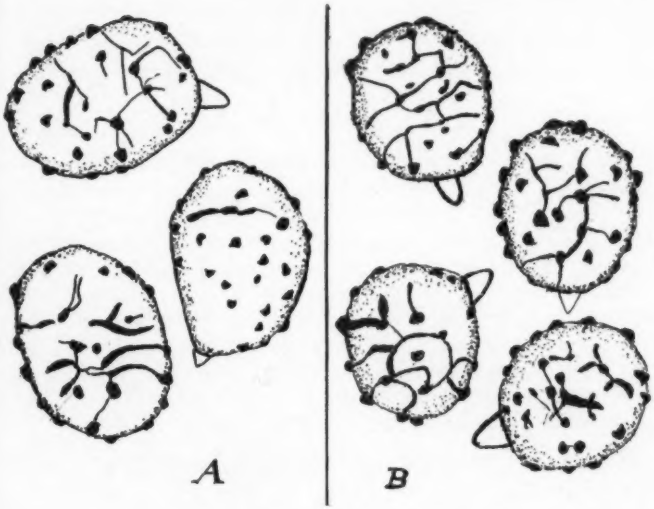

FIG. 3–*A*. Spores of *Russula marginata*.
FIG. 3–*B*. Spores of *Russula mordax*.

with red, more deeply colored in same places, paler at the junction with the lamellae, nearly equal, blunt at the base, 8 cm. by 3 cm.; spores ochroleucous in mass, 6.5–7.5 $\mu \times$ 7.5–8.75 μ, with protuberances of varying size, many connected by bands or fine lines, apiculate.

TYPE LOCALITY: Seward Park, Seattle, Washington.

HABITAT: Under Douglas fir in a rather open place, November.

Pileo convexo explanato subdepressoque, ex latericio sanguinco-brunneo, jove pluvio viscido; margine reflexo, levi; carne alba, immutabili, sine odore, acerrima; lamellis aequalibus, furcatis, venoso-connexis, postice attenuatis, confertis; stipite rubello, subaequali, 3 × 8 cm.; sporis ochroleucis, 6.5–7.5 $\mu \times$ 7.5–8.75 μ.

This species differs from *Russula badia* Quél., in the taste being instantly acrid, the lamellae not sinuate, in the lack of odor, and in the color, shape, size and markings of the spores. From *Russula tenuiceps* Kauff., it differs in the even margin, the closer lamellae, firmer texture, the paler, reticulate spores. The habit is not gregarious. In color it resembles *Russula astringens* Burl.

Only the type collection has been made but the information secured was so complete and decisive and the condition when dried so good that one would have no difficulty in recognizing the species.

LACTARIA OBNUBILA (Lasch) Fries (FIG. 4–*A*).

Pileus very thin, plane with a slight papilla, then infundibuliform, up to 4 cm. broad; surface raw umber tone 4 or sepia to snuff brown, paler toward the margin, azonate, viscid when wet but not slimy; margin even at first becoming striate-tuberculate half way to the center; context fragile, odorless; latex white, unchanging, mild; lamellae dark fawn (307 t. 1–4), unequal, a few forking next the stipe, close, slightly decurrent; stipe burnt umber (304) to mineral brown (339 t. 4), brightest colored and tomentose at the base, .7 × 4.5 cm.; spores white, reticulate, with raised bands and protuberances, 7.5–8.75 μ × 8.75–10 μ, broadly elliptical, apiculate, unsymmetrical.

HABITAT: In moist black soil under alders (*Alnus oregona*) or on alder wood.

DISTRIBUTION: In several localities in the vicinity of Seattle, Washington, and near Rhododendron, Oregon.

In Nov. 1927 Dr. Hotson found specimens of this species under alders in a moist ravine on the campus of the University of Washington at Seattle. In September 1931 Dr. J. E. Lange and Dr. S. M. Zeller collected specimens under alders at Rhododendron, Oregon. In Nov. 1934 Daniel Stuntz collected the species in several localities outside of Seattle, Washington, and I found it growing abundantly in an alder bottom near the campus of the University of Washington on October 29. The accompanying photograph was made of specimens from this collection. Since no description of this species occurs in our literature, I have included a full description. While the latex is mild, there is a slight astringent taste to the flesh when chewed. Dr. Lange has seen specimens of the Washington collection from which the photograph was made and considers the species the same as *Lactarius obnubilis* which he has described in "The Agarics of Denmark."

Lactaria luculenta sp. nov. (FIG. 4–*B*).

Pileus broadly convex or almost plane with inrolled margin, slightly papillate becoming centrally depressed with the papilla dis-

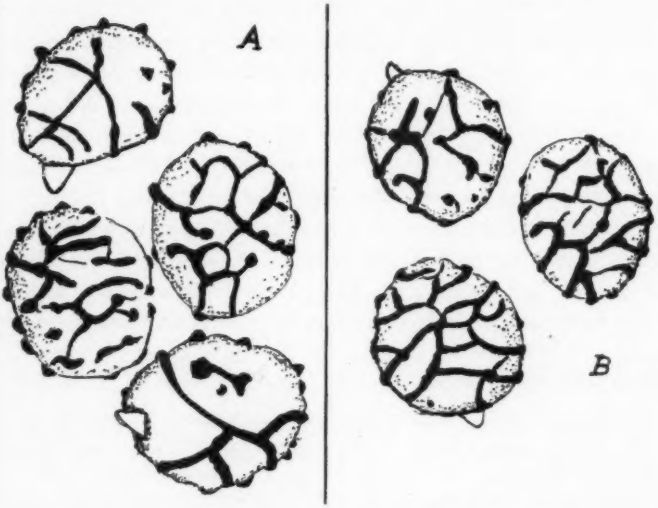

FIG. 4–*A*. Spores of *Lactaria obnubila* (Lasch) Fries.
FIG. 4–*B*. Spores of *Lactaria luculenta*.

appearing, up to 7.5 cm. broad; surface isabelline tone 1–3 when moist in the field, pitchpine to brownish terra cotta (322 t. 1–4) as the viscidity disappears, slimy viscid when wet, glabrous; margin even becoming slightly striate on the very edge when mature; context pale flesh tone 4, a little bitter then slowly acrid; latex white, unchanging, a little astringent, mild or tardily making the tongue sting slightly; lamellae cinnamon tone 1 singly, isabelline in position, unequal, simple, adnate to decurrent by a tooth, close; stipe isabelline to fawn or brownish terra cotta, slightly deeper colored toward the base, firm, becoming hollow, .7–1.5 cm. × 2–5 cm.; spores fleshy white, ellipsoid, with reticulate bands and some protuberances, 6.25–6.87 μ × 7.5–8.1 μ.

TYPE LOCALITY: Woodcock's Hill, Corvallis, Oregon.

HABITAT: Under Douglas fir. Gregarious.

DISTRIBUTION: In various localities around Corvallis, Oregon, and in Muir Woods, California.

Pileo e papillato convexo, explanato depressoque, viscoso, azono, isabellino vel cinnemoneo, glabro, 3.5–7.5 cm. lato; carne isabellina, tarde acri; lacte albo, submiti; lamellis isabellinis, inaequalibus, adnatis vel subdecurrentibus; stipite isabellino vel fulvo, e farcto cavo, glabro, 1–1.3 cm. × 2–5 cm.; sporis albidis, reticulatis, ellipsoidis, 6.25–6.87 μ × 7.5–8.1 μ.

This species belongs in the group with *Lactaria aurantiaca* Fries, but differs in being slimy viscid when wet, the lamellae scarcely decurrent, the latex scarcely acrid although the flesh makes the tongue sting slightly when it is thoroughly chewed, and the color of the pileus is paler, verging more on yellow than orange while the spores are a little smaller and more reticulate. This has probably been reported as *Lactaria mitissima* Fries from which it differs in the slimy viscidity of the pileus and the slight acridity of the context. According to Fries, the pileus of *Lactaria mitissima* should be dry, the latex mild as the name implies, the taste rarely somewhat bitter, and the habitat principally in deciduous woods.

Russula Californiensis sp. nov. (FIG. 5–*A*, 8).

Pileus broadly convex, expanding, becoming centrally depressed with margin arched or spreading, rather firm, 8.5 to 24 cm. broad; surface old-blood red to peach red or coppery red, sometimes Naples yellow over the center, viscid when wet, with the cuticle separable half way to the center, glabrous; margin even or sometimes obscurely coarsely striate tuberculate on the extreme edge when mature; context white, becoming pale gray especially in the stipe as it begins to dry or with age, acrid when young, less so with age, with no special odor; lamellae flesh color tone 4 singly, pale ecru tone 4 in position, equal, many forking near the stipe, a few elsewhere, interveined, rounded at the outer end, gradually narrowed toward the inner end, then depressed near the stipe and attached by a tooth, close, acrid at all ages; stipe white becoming pale gray with age or in drying, firm, usually 1.3–4 cm. by 8–10 cm., extreme size 5.5 cm. at the base, 7.5 cm. at the apex by 18 cm. in length, varying in shape but inclined to be ventricose, stuffed; spores honey yellow tone 1 to 2, covered with protuberances of varying size and shape, often connected by fine or thicker lines giving them a reticulate appearance, 7.5–8.75 $\mu \times$ 9–10 μ.

TYPE LOCALITY: Pacific Grove, California.

HABITAT: Under Monterey pine and California live oak.

DISTRIBUTION: Common in various localities in the vicinity of Pacific Grove, California.

Pileo firmo, convexo-explanato, depresso, glabro, jove pluvio viscido, pellicula subseparabeli, sene-sanguinea pallidioreve, 8.5–25 cm. lato; margine reflexo patenteve, levi, infrequenter leviter striato-tuberculoso; carne alba, fracta tarde subcinerascente, acri; lamellis pallidis, aequalibus, postice

furcatis et attenuatis sed proxime stipitem rotundatis et adnectis dente, venoso-connexis, confertis; stipite albo tarde cinerascente cum siccescit, inaequali, farcto, 1.3–4 cm. × 8–18 cm.; sporis melleis, 7.5–8.75 μ × 9–10 μ, reticulatis.

This species differs from the other species in the Veternosae group in the change of the color of the surface of the stipe and the context from white to pale gray with age or as the mushroom dries. The gray stipe is very noticeable in the field in dry weather as the mushroom reaches maturity. The gray color is not prominent when the specimens are finally dried. The acrid taste separates it from the red capped species with flesh becoming gray. The acridity is most pronounced in the lamellae where it persists. During December and January this was the most abundant species in the woods around Pacific Grove. In size and bright coloring it is so typical of California that the specific name given seems appropriate.

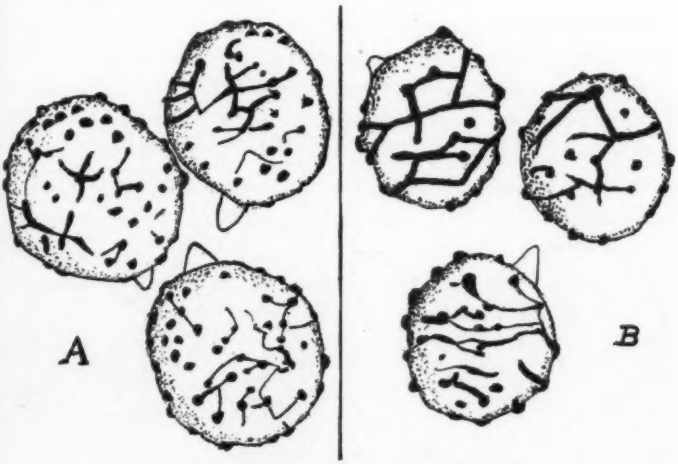

FIG. 5–*A*. Spores of *Russula Californiensis*.
FIG. 5–*B*. Spores of *Lactaria rufula* Peck.

LACTARIA RUFULA Peck (FIG. 5–*B*).

This species has previously been reported only from California. It occurs abundantly in spruce woods near Agate Beach Inn, Agate Beach, Oregon, during November. It differs from *Lactaria rufa*

(Scop.) Fries in the thinner pileus, with a fluted and sometimes striate margin, absence of an umbo, the more slender stipe, the adnate lamellae, and the latex being slowly acrid with sometimes a bitter taste at first. The spores from specimens of *Lactaria rufa* which I collected in Sweden are smaller and have finer lines connecting the protuberances. The surface of *Lactaria rufula* is slightly viscid in wet weather.

RUSSULA ROMELLII Maire (Bull. Soc. Myc. Fr. **26**: 107. 1910. *fig. 1* (FIG. 6–*A*).

This species is closely related to *Russula alutacea* from which it differs chiefly in the spore markings. It was collected Dec. 27, 1927 in pine woods at Pacific Grove, California. It has not been previously reported from the United States. The specimens agree in all respects with specimens which I collected in Sweden in 1930. The pileus was vinaceous on the margin fading with age, maize yellow in the center, viscid when wet, with the margin becoming striate tuberculate on the extreme edge. The lamellae were pallid at first, then yellow, close, some forking near the inner end, and attached; the spores are ochraceous, $7.5 \times 8.75\,\mu$ to $8 \times 10\,\mu$, reticulate. The stipe was white in all specimens collected.

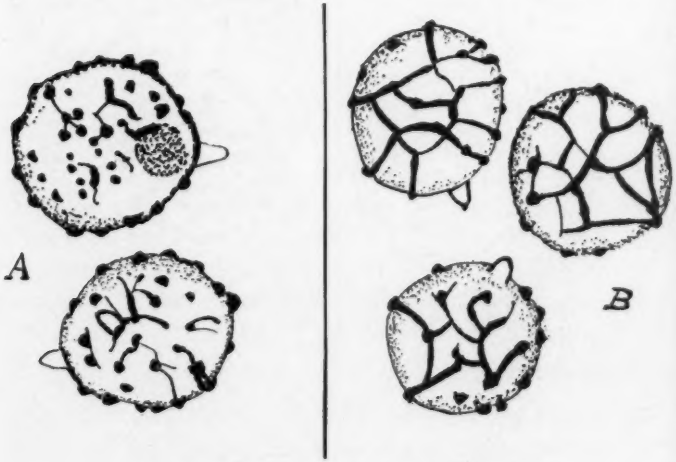

FIG. 6–*A*. Spores of *Russula Romellii* Maire.
FIG. 6–*B*. Spores of *Russula Mariae* Peck.

RUSSULA VESCA Fries.

Specimens of this species were collected near Waldport, Oregon (6 Nov. 19—'34), and on the Beach Road between Newport and Agate Beach, Oregon (8 Nov. 27—'34). It has not been previously reported from the Pacific Coast. It is characterized by the mild taste, white spores, and reddish or Van Dyke brown pileus. In Hymenomycetes Europaei and other publications Fries classed *Russula vesca* with the Heterophyllae, but in his painting which I examined in Stockholm the lamellae are plainly equal, Specimens which I collected around Upsula all showed the equal lamellae and were almost exactly the color of the species which I described as *Russula brunneola* (N. Am. Flora **9**[4]: 233). While the painting by Fries shows a red pileus, the color seems more often to verge into some shade of brownish red. The spores of *Russula brunneola* are like those of *Russula vesca,* and there seems no doubt that *Russula brunneola* becomes a synonym of *Russula vesca* Fries. The spores agree in markings with those shown in Pl. IX in Spore Ornamentation of the Russulas by R. Crawshay. The lamellae are inclined to have rusty colored spots.

RUSSULA SANGUINEA (Bull.) Fries.

This species characterized by the blood-red pileus and the stipe usually tinted more or less with the same color, while the lamellae are white with pale yellow spores (pale ecru tone 4 to honey yellow tone 1 in mass) and the acrid taste was collected south of

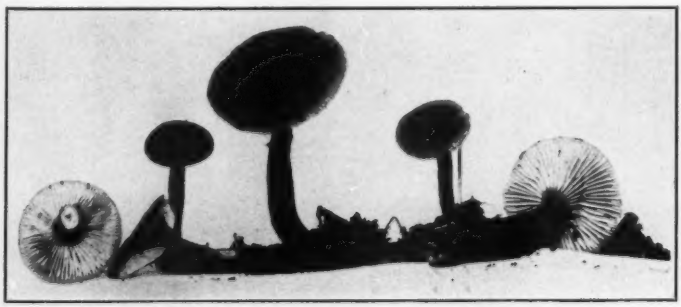

FIG. 7. *Lactaria obnubila* (Lasch) Fries.

FIG. 8. *Russula Californiensis* Burl.

Meadowdale, near Seattle, Washington, by David Stuntz (No. 2 Oct. 11—'34). I collected it at Newport, Oregon, under lodgepole pines (No. 1—Nov. 17—'34); under pines south of Corvallis (6 Nov. 16—'27), and under Monterey pines at Pacific Grove, California (11 Jan. 4—'35).

RUSSULA MARIAE Peck (FIG. 6–*B*).

In the Annual Report of the N. Y. State Museum **24**: 74. 1872, Dr. Peck described *Russula Mariae*. Iu 1880 Quelet described *Russula amoena* in Ass. Fr. Avais. Sc. **9**: 8. Specimens of the latter sent me by Julius Schaeffer seem to be identical with Peck's species, even to the spore ornamentation. Maire considers *Russula amoena* to be the same as *Russula punctata* Gill. Champ. Fr. 245. 1879. I have not seen specimens of *Russula punctata,* but *Rusula amoena* is without doubt synonymous with *Russula Mariae,* and if Maire is correct in his determination, Gillet's species is also reduced to the same synonymy.

The spore drawings have been made with the aid of a camera lucida, using an iodine solution prepared according to the formula of Crawshay. Unless otherwise stated the colors given in descriptions are those found in the Repertoire de Couleurs. Specimens of the types and other species included in this article have been placed in the herbarium of The New York Botanical Garden, and with the exception of *Russula mordax,* in my herbarium. Excepting also the latter species, specimens have been filed in the herbarium of the University of Washington in Seattle, and that of the Oregon State College at Corvallis.

I am much indebted to Dr. J. W. Hotson of the University of Washington and to Dr. S. M. Zeller of the Oregon State College for supplying facilities for studying and drying specimens and for assistance in collecting.

FALSE MILDEW OF RED MULBERRY

FREDERICK A. WOLF

(WITH 3 FIGURES)

For several years the writer has been interested in a survey of the plant diseases that occur within the area comprising the Duke Forest. Among the diseases to which special study has been devoted is one that involves the foliage of the red mulberry, *Morus rubra* L., to which name false mildew may be appropriately applied. Its causal agency, both in its conidial and its perithecial stage, appears to be specifically distinct from any fungi that have been reported to occur on *Morus*, and in consequence, consideration has been given to its morphology and cycle of development. The results of this study on the false mildew organism are herein assembled as a further contribution to our knowledge of the diseases affecting trees within the Duke Forest.

APPEARANCE OF THE DISEASE

As indicated by the term false mildew, this disease is characterized by the presence of an effuse, white, cob-webby coating that simulates the appearance of a powdery mildew (FIG. 1, 2). It is first apparent during July when scarcely-evident, whitish, indefinitely-limited patches may be noted on the under sides of the leaves. At this stage, there is little if any apparent discoloration when affected leaves are viewed from the upper leaf surface. By the time that the whitish patches are one-quarter to one-half inch or more in diameter, however, yellowish areas are discernible on the upper side. These areas become necrotic early in autumn and large irregular brownish spots are then present.

THE CONIDIAL STAGE

Upon microscopic examination it becomes apparent that the whitish coating is imparted by the superficial, reproductvie mycelium together with the profusion of conidia. The reproductive

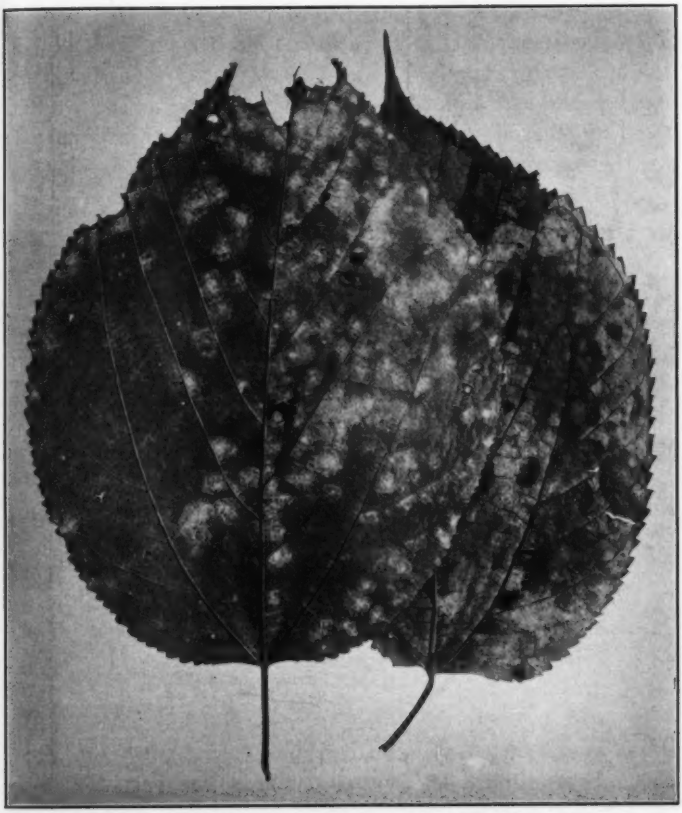

FIG. 1. Leaves of red mulberry, showing effuse whitish areas on the lower leaf surface, caused by *Cercosporella arachnoidea*.

mycelium, emerges from the stomates. It courses over the leaf surface forming a closely appressed, branched, tangled, hyphal weft, and is dependent for its nourishment upon the internal, intercellular mycelium. At intervals short knob-like, lateral branches arise singly from the reproductive hyphae. These lateral branches function as conidiophores (FIG. 3, *B*). Each conidiophore produces acrogenously a quantity of conidia that arise singly and are dislodged at maturity. The conidia are hyaline, septate, blunt-pointed, and range in size from 40–70 × 3.75–4.5 μ (FIG. 3 *A*).

The morphological features of the organism under consideration are similar generically to those of a widely known pathogen on peach, *Cercosporella persica* Sacc., the type upon which the genus *Cercosporella* is based. Attention may be directed to the fact that the description of *C. persica* in Saccardo's Sylloge Fungorum (4: 218) is inadequate and that our knowledge of its morphology has been clarified by the investigations of Tsuji (3).

THE PERITHECIAL STAGE

Examination of leaves, collected during October, shows that the perithecial stage is initiated just prior to the abscission of the leaves. The surface of the necrotic tissues, at this time, may be noted to be densely occupied on the upper leaf surface by dark spermogonial and perithecial primordia. Both structures may be intermingled, however, on both leaf surfaces. The spermogonia are at first dense, spherical stromata wholly embedded within the leaf. Spermatial formation is initiated by the disintegration of the innermost cells of the stromata, a process which proceeds centrifugally. Eventually the spermatia entirely fill the spermogonial cavity. The wall, at maturity, is a single cell-layer in thickness. The spermogonia range in size from 40 to 65 μ. The spermatia are rod-shaped, hyaline, and measure approximately $4 \times 1.25\,\mu$, fig. 3, *D*.

In order to study the development of the perithecia affected leaves were collected and piled in a suitable location on the forest floor. Some of these leaves were examined at intervals throughout the winter and spring and as a result it was found that the perithecia are mature by May.

In the early stages, perithecial primordia are morphologically indistinguishable from spermogonial primordia. After spermatial production has ceased, however, they remain as compact stromata whose innermost cells have a deeply-staining content. By spring the perithecial stromata will have enlarged to the extent that they project about half their height above the surface of the decaying leaves (FIG. 3, *H*). At this stage, as seen with low magnification, they appear as black points, densely aggregated into black patches, hundreds being present in an area one or more centimeters across. Mature perithecia vary from 80–100 μ in diameter. They open

by means of a perforation through a short papilla. Their wall is constituted of a thin layer of brown-walled cells. If the perithecia are crushed in a drop of water on a microscopic slide, the asci may be seen to adhere in a fascicle. No paraphyses are present. The asci measure 45–54 × 7–8.5 μ (FIG. 3, *G*). The ascospores are arranged biseriately, are hyaline, 2-celled, curved, and measure 14–17 × 3.5–4 μ, the upper cell being slightly longer and wider than the lower (FIG. 3, *E*).

The structural features of the perithecia of this organism on mulberry leaves, as just described, are manifestly those of the genus *Mycosphaerella*. The connection of the *Mycosphaerella* stage with the *Cercosporella* stage that preceded it is based upon evidence (1) from cultures and (2) from inoculation experiments.

Cultures were isolated both from conidia and from ascospores. Isolations from conidia were obtained by the dilution method in potato agar plates, using a watery suspension of conidia as inoculum. Isolations from ascospores were obtained by permitting the ascospores to be forcibly ejected onto inverted potato agar plates. The colonies that develop on this substratum are slow-growing, rather compact, and white to faintly pink. No evidence of conidial production in cultures has been noted. The colonies that originate from conidia, however, are entirely like those originating from ascospores.

Since the organism could not be induced to fruit in culture it was impossible to use pure cultures for inoculations. In consequence it was necessary to use leaves bearing perithecia, as inoculum. Fragments of such leaves were accordingly applied to healthy mulberry leaves. The inoculum was held in place by means of bits of paper towels, that served, in addition, in keeping the inoculum moist after rains. Three to four weeks after inoculation a whitish coating consisting of mycelium and conidia was present on the inoculated leaves. Upon examination these conidia were found to be morphologically identical with those of the *Cercosporella* that had been originally observed to be pathogenic to red mulberry.

IDENTITY OF THE PATHOGEN

Two species of *Cercosporella* have previously been reported to occur on mulberry, *C. Mori* Peck, and *C. maculans* (Bereng.) Wolf. The former was first collected, in Texas, on *Morus alba*, by Heald and Wolf (2), and specimens were sent to Peck for identification. He named the fungus but did not describe it. The description was subsequently prepared by Heald and Wolf (2). The latter species as it occurs on red mulberry was recently studied by Wolf (1) and found to possess a perithecial stage, *Mycosphaerella Mori* (Fuckel) Wolf. Both of these species of *Cercosporella* cause the formation of definite-margined leafspots, both bear conidia that are abstricted from small fascicles of conidiophores that emerge from the stomates; and both produce conidia that are pink en masse. The *Cercosporella* under consideration is obviously distinct from both of these species. A search among the collections in the Farlow Herbarium, Harvard University and among those of the Mycological Herbarium of the United States Department of Agriculture has disclosed nothing on mulberry and closely related species that is identical with this false mildew fungus. Apparently it has never been described. The conidial stage is accordingly designated *Cercosporella arachnoidea*, a name which appropriately characterizes the gross appearance of the fungus on affected leaves.

Four species of *Mycosphaerella* (*Sphaerella*) are known to occur on species of *Morus*. In order to facilitate comparison of these four species with the false mildew fungus, the following tabulation has been arranged.

In explanation, it may be stated that *Sphaerella Mori-albae*, for which no measurements are recorded,[1] is synonymous with *Sphaeria Mori-albae* Schw. Its perithecia are borne on the lower leaf surface, and in addition, they are large and are grouped in small irregular areas. It is therefore, entirely unlike the false mildew organism. Both *Sphaerella morifolia* and *Mycosphaerella Mori* are obviously clearly distinct from the organism under consideration but it bears a close resemblance to *M. moricola*. *M. moricola* is not included in Saccardo's Sylloge Fungorum but was described,

[1] Sacc. Syll. Fung. 2: 438; Ondemans, Enum. Syst. Fung. 2: 901.

TABLE I

COMPARISONS OF SPECIES OF MYCOSPHAERELLA ON *Morus* SPP.

Organism	Location of perithecia	Perithecial size μ	Ascal size μ	Size of ascospores μ
Sphaerella morifolia Pass.	Hypophyllous	.....	50–55×10–15	17–25×5.0–5.5
Mycosphaerella moricola Sawada	Hypophyllous	36–75×32–71	28–43×8–10	16–18×3.5
Mycosphaerella Mori (Fkl.) Wolf.	Epiphyllous	60–80	35–40×55–6.5	12–14×3.5–4
Sphaerella Mori-albae Cooke.	Hypophyllous	.....	.....	.....
False mildew fungus	Amphigenous, mostly epiphyllous	80–100	45–54×7–8.5	14–17×3.5–4

FIG. 2. Slightly enlarged view of a diseased leaf bearing lesions coated with *C. arachnoidea*. The gross appearance is that of a powdery mildew.

in 1919, in the Japanese language.[2] It has thus far been impossible to secure type specimens of *M. moricola*[3] and thus to make a

[2] Sawada, K. Descriptive catalog of the Formosan fungi. Part 1, 94–95, 1919.

[3] I have been able to examine specimens of *M. moricola*, through the efforts of Dr. G. D. Darker, since this manuscript was prepared. These specimens were collected in Formosa, on May 10, 1909, by Sawada. They show perithecia formed sparingly on the lower surface of lesions on green leaves of *Morus alba*. *M. moricola* is therefore specifically distinct from *M. arachnoidea*.

proper comparison. Evidently *Sphaeria moricola* Ces. represented in exsiccati, in Rabenhort's H. M. I. No. 1561, 1851, is antedated by *Sphaeria moricola* Schw. that has been set aside as a nomen nudum.

Whether *Mycosphaerella moricola* possesses a conidial stage is unknown since none is mentioned in Sawada's account.[2] The position and size of perithecia of *M. moricola* and the false mildew fungus differ, although the sizes of their asci and ascospores are quite in accord. Less confusion would appear to result at this time, since the developmental cycle of *M. moricola* is unknown, and comparison of specimens has not been possible, were the false mildew to be regarded as specifically distinct. It is therefore given the new specific name *arachnoidea* to indicate the powdery mildew-like character of the conidial stage. The name *erysiphoidea* would have been preferred were it not already preempted.

Mycosphaerella arachnoidea sp. nov.

Syn. Cercosporella arachnoidea nom. nov.

Peritheciis dense aggregatis, in maculis majusculis, amphigenis vulgo epiphyllis, erumpenti-superficialibus, atratis, papillatis, membranaceis; ascis base fasciculatis, aparaphysatis, oblongo-clavatis, octosporis, 45–54 × 7–8.5 μ; ascosporis biseriatis, curvulis, uniseptatis, constrictis, leniter inaequalibus, loculo superiore longiore atque crassiore, 14–17 × 3.5–4.0 μ.

Hab. in foliis dejectis atque putridis, *Mori rubrae,* in verno.

Status spermogonicus: Stromatibus spermogonicis in autumno efformantis, dense gregariis, plerumque epiphyllis; spermogoniis initio pseudoparenchymaticis, intus loculo spermogonico oriunde, 40–65 μ; spermatiis bacilliformibus, hyalinis, 4.0 × 1.25 μ.

Status conidicus: Statum conidicum *Cercosporella arachnoidea* sistit. Maculis flaventis deinde brunneis; fertile mycelio erysiphoideo, ectophytico, hypophyllo; conidiophoris bursiformis, apice conidia gerentibus; conidiis vermicularibus, pluriseptatis, guttulatis, hyalinis, 40–70 × 3.75–4.0 μ.

Hab. in foliis vivis *Mori rubrae,* in aestivo.

For the convenience of mycologists type specimens, bearing perithecia and others bearing conidia have been deposited in the Farlow Herbarium, Harvard University, Cambridge, Mass., and in the Mycological Herbarium of the United States Department of Agriculture, Washington, D. C.

Grateful acknowledgment is made for the help and advice given by D. H. Linder, G. D. Darker and W. W. Diehl.

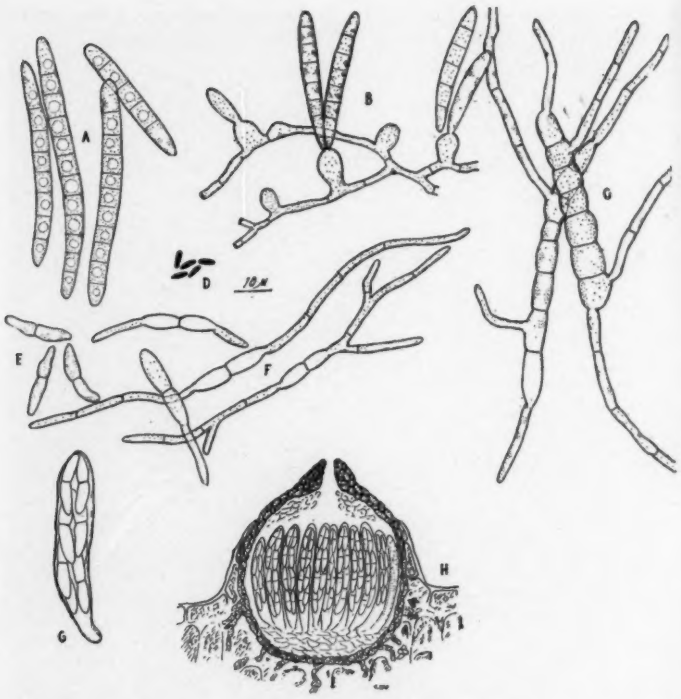

FIG. 3. *A–G* are drawn to the same scale, indicated near *D*. *A*, conidia of *C. arachnoidea; B*, fertile, superficial hyphae, bulbous conidiophores and conidia as shown by free-hand sections cut parallel to the leaf surface; *C*, germinating conidia; *D*, spermatia; *E*, ascospores of *Mycosphaerella arachnoidea; F*, germinating ascospores that were discharged on agar plates; *G*, mature ascus of *M. arachnoidea; H*, sketch of mature perithecium of *M. arachnoidea.*

SUMMARY

This report is concerned with the developmental morphology of a pleomorphic fungus that causes false mildew of mulberry. It possesses a conidial stage, that imparts to affected foliage the gross appearance of a powdery mildew and that is herein designated *Cercosporella arachnoidea.* At the time of leaf abscission in autumn the lesions are occupied by spermogonia and perithecial

primordia. The perithecial stage matures in spring. The pathogen is herein described as *Mycosphaerella arachnoidea*.

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THE DEVELOPMENT OF LYCOPERDON ACUMINATUM

DELBERT SWARTZ [1]

(WITH 9 FIGURES)

Our knowledge of the comparative development of species of Lycoperdaceae is gradually increasing. In addition to the review of literature given by the writer (**4**, **5**), an additional paper on *Calvatia craniiformis* (Schw.) Fries has recently appeared (**6**). The following study of the development of *Lycoperdon acuminatum* is the eighth in a series of developmental studies on species of Lycoperdaceae by the writer.

MATERIALS AND METHODS

The fruit bodies used in these studies were collected on the bark of living oak trees near Fayetteville, Arkansas, during October and November, 1934. They ordinarily occur soon after the first cool fall rains in this part of the southwestern United States. They were killed in Flemming's weaker solution and embedded in paraffin. Serial sections were cut 7 μ in thickness, and stained in Heidenhain's iron-alum haematoxylin.

OBSERVATION

Description of the fruit body: Fruit body at first globose, becoming ovoid to pointed egg-shaped; whitish to cream color, becoming brownish in age; usually less than 1 cm. in diameter; opening by a small apical pore. Cortex smooth, slightly wavy (rarely otherwise) (**1**). Sterile base absent in mature specimens. Gleba olive to pale-brown. Capillitium lacking until maturity or near maturity, simple (rarely branched), lighter than spores; usually twice as thick as the spores. Spores globose, smooth or very slightly roughened, 3.5–4 μ in diameter.

[1] Research paper, Journal Series, University of Arkansas, No. 397.

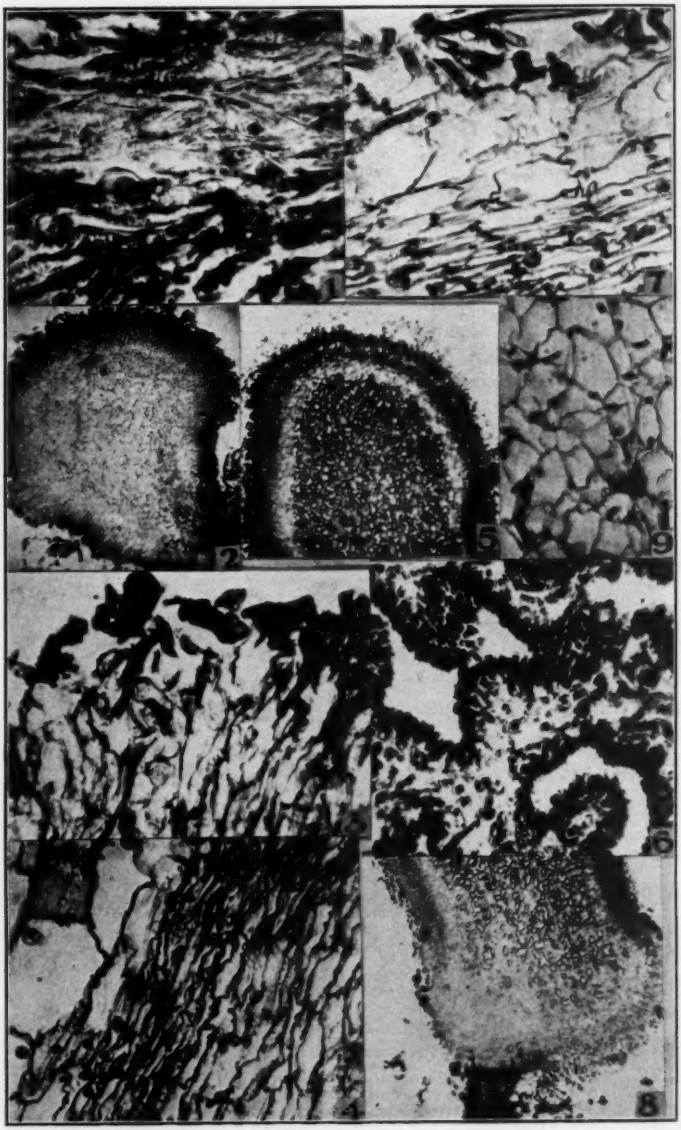
Usually growing on bark of living trees 3–15 feet above ground.

Rhizomorph: The rhizomorphs are short, and, on the whole, are very poorly developed. They branch near the base of the fruit body, and these branches may penetrate the bark of the tree to a depth of 0.5–1.0 cm. There are three layers in the rhizomorph (FIG. 1); namely, (1) an outer cortex, (2) a very thin poorly developed subcortex; and, (3) a central core. The outer cortex is relatively thin, and is composed of loosely connected hyphae, which are coarse, blunt, and which stain deeply. The poorly formed sub-cortex is made up of slightly interwoven, thin-walled hyphae which are parallel to the long axis. These hyphae do not stain deeply, and are continuous with the cortex on the outside, and with the central core on the inside. The central core is not so well developed as in other species, and the component hyphae are somewhat thicker than those of the subcortex. They contain a few deeply staining, angular crystals similar to those reported in other species (**2**, **3**, **4**, **5**, **6**).

The rhizomorph is sometimes imbedded in a pseudoparenchymatous matrix which is also connected with the base of young fruit bodies. This rather unusual condition has not been observed in other species, and is probably a reaction to the unusual habitat.

Formation of the fruitbody: The fruitbody arises from the end of the very short rhizomorph as in other investigated species (**4**, **5**, **6**). It is roughly spherical at first, and the interior is undifferentiated (FIG. 2). When very young it is sparsely covered by the cortex of the rhizomorph, but with elongation and enlargement these hyphae persist only at the base. The undifferentiated interior is continuous with the central core while the outer covering is connected to the subcortex. The youngest plants have no peridia, and the periphery is made up of relatively loosely interwoven hyphae whose ends make up the outer margin of the fruit body. The outer fringe stains more deeply than the inner part of the peripheral zone. Between this more deeply staining fringe and the inner part, there is another zone of hyphae which does not stain so deeply as the tissue in the central part of the young fruit body.

Exoperidium: The hyphae at the apex of very young fruit bodies become radially arranged (FIG. 3); this is the initiation of the exoperidium. Gradually this radial arrangement spreads until



FIGS. 1–9. Development of *Lycoperdon acuminatum*.

the entire fruit body is covered by a relatively thin layer of such hyphae. The outer fringe is soon covered with many loosely connected, globose cells, which are very rich in protoplasm and which stain very deeply. Just beneath this peripheral layer, a layer of pseudoparenchyma is laid down (FIG. 4), and the innermost cells elongate tangentially and pass directly into the inner peridium. The exoperidium is not so thick in this species as in certain others, but it is well developed when considered in relation to the total diameter of the fruit body. The general wavy outline of the outer margin is due to the uneven thickening of this outer layer (FIG. 5).

Endoperidium: The differentiation of the endoperidium begins soon after the radial arrangement of the peripheral hyphae, and it is first visible in the region where the exoperidial hyphae become elongated tangentially. At first this layer is thin and indistinct, but it gradually becomes thicker, and more clearly visible. The hyphae are continuous with the exoperidium on the outside, and with the gleba on the inside. As the exoperidium gradually wears away, the smooth endoperidium is exposed. Scattered patches of pseudoparenchyma from the exoperidium may persist for some time; these areas are usually much more numerous at the base than at the apex.

Gleba: The primordial hyphae of the gleba are continuous with those of the central core. The region of the gleba is first visible because the hyphae are richer in protoplasm, and stain more deeply than those of the layer surrounding it. Cavities arise by mechanical splitting in this homogeneous region of rather loosely interwoven hyphae. The cavities enlarge as in other species (**4**), and soon become lined with a regular hymenium (FIG. 6). The first formed cavities are formed in the apical part (FIG. 5); and they gradually appear toward the basal region (FIG. 8). This cavity formation continues until the entire gleba, with the exception of a rather thick permanent layer of pseudoparenchyma just within the endoperidium (FIG. 7), is thoroughly perforated by cavities. After cavity formation has continued for some time, spores are formed. During spore formation the hyphae of the gleba are completely used up; this includes both the subhymenium and the trama which are both very poorly developed in this species. The

outlines of the cavities persist for some time due to the arrangement of the spores in their characteristic position around it. Gradually, the dry powdery spore mass escapes through the apical pore.

Sterile base: The youngest fruit bodies have a tissue in the basalmost part which is suggestive of a sterile base (FIG. 8). However, all of this tissue is used up during spore formation, and no remnants of it are visible in mature plants.

Capillitium: The capillitium is not definitely localized in the gleba in this species; instead, it is present in greatest amount in the pseudoparenchyma just inside the endoperidium (FIG. 9); and only a few scattered threads are found elsewhere. The threads are usually simple although they may branch occasionally.

Pore formation and dehiscence: The spores, when ripe, are gradually freed through an apical pore which is formed in the following manner. Simultaneous with the gradual wearing away of the exoperidium, the tangential hyphae at the apex of the fruit body break apart and bend outward. The layer of pseudoparenchyma just beneath this newly formed opening breaks down. In this way a continuous opening from the spore filled gleba to the outside is formed. This outward turning of these endoperidial hyphae causes the apex to have a pointed appearance. At first this pointed region is fairly rigid, but it gradually collapses during dehiscence.

SUMMARY

Lycoperdon acuminatum develops similarly to other investigated species of Lycoperdaceae. The fruit bodies arise from a poorly developed rhizomorph whose branches penetrate for some distance between the cells of the bark.

The exoperidium is formed early, and results from a radial arrangement of peripheral hyphae. It soon becomes made up of a very loose outer fringe, and a pseudoparenchymatous inner part.

The endoperidium results from a tangential rearrangement of hyphae just within the exoperidium; this is the outermost layer in completely mature fruit bodies.

The gleba is differentiated as in other species; the first cavities appear toward the apex, but gradually the entire interior including

the sterile basal part is used up. The subhymenium and the trama are very poorly formed.

The greater number of threads of capillitium are formed in the layer of permanent pseudoparenchyma just inside of the endoperidium; relatively few threads are scattered through the gleba.

A comparison of these developmental characters with those of other species which have been studied indicate that it is most closely related to *Lycoperdon Wrightii.*

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SPERMATIA AND NUCLEAR MIGRATIONS IN PLEURAGE ANSERINA

B. O. Dodge

(with 2 figures)

The formation of microspores by certain ascomycetes has long been known. Their function in fertilization was for many years taken for granted, although this was not actually proved for any species until very recently. A study of the many different ways in which fertilization is accomplished in ascomycetes has served to raise questions regarding the importance or the necessity for spermatia. Certainly for the heterothallic species they are well adapted to insure cross-fertilization with opportunities for hybridization and the development of new races. The modern tendency, however, for those who discover spermatia of an ascomycete for the first time is to magnify their importance and to insist on their necessity, ignoring all the other ways these same fungi have of insuring cross-fertilization. Few persons who have studied species of *Neurospora* even intensively have ever seen their spermatia. In many species of ascomycetes spermatia are not developed at all, while in others they are only occasionally found. Races of *Gelasinospora tetrasperma* which have spermatia may yet be found. We should know in every case how spermatia originate and how they function both sexually and asexually if we are to understand the interrelations of species in the scheme of their evolution.

Judging from the morphology of their ascocarps, species of *Neurospora* must be closely related to the Sordariaceae. Further evidence for such a relationship is found in the similarity in the spermatial apparatus of *Neurospora* and *Pleurage*. In *Neurospora* (**Dodge, 1932**) spermatia are usually borne on specialized branches (l. c. *fig. 1*) each of whose cells may be called a spermogonium. The spermatia are probably not actually organized as

endoconidia yet they present the appearance of being squeezed out through the characteristic collar-like or inverted bell-shaped opening of which there is only one for each cell or spermogonium. The spermatia may adhere in short chains and later gather together in great numbers in droplets of water. Spermogonia may also arise more or less singly from surface hyphae as noted in the paper referred to.

A paper by Satina (**1917**) on the development of species of the Sordariaceae contains some very interesting information which has not been noted in subsequent discussions on nuclear behavior and spermatia in the ascomycetes. Under *Podospora curvula* she says, "The conidia with one nucleus develop in enormous quantities in short swollen cells, which appear on hyphae on side branches (*fig. 17*). One could not succeed in germinating the conidia." Persons familiar with spermatia of *Neurospora* and other ascomycetes will understand that Satina had what we call microconidia or spermatia under observation. Although her figure 17 is rather sketchy there is the suggestion of a flaring bell-shaped collar at the opening of the spermogonium. Discussing *Podospora* (*Pleurage*) *anserina* Satina says: "All above stated of *P. curvula* can be fully attributed to *P. anserina*." There can be no doubt that this statement was intended to cover what had been said about the "conidia" (spermatia). In a personal communication Dr. Satina says that she saw spermatia of *P. anserina* and that they looked much like those of *P. curvula*. She had made a number of drawings of them for that paper, but owing to the unfavorable conditions for publication in Russia at that time she was obliged to eliminate them. Satina was likewise the first to confirm Wolf's statement (**1912**) that each of the four spores in an ascus contains two nuclei. Dowding (**1931**) has further confirmed Wolf on this point.

Through the kindness of Dr. E. Silver Dowding (Mrs. Keeping) and Dr. R. F. Cain, I was able to obtain cultures of *Pleurage taenioides* and *P. anserina* for this preliminary study. Since all species of *Neurospora* studied show a fourth simultaneous nuclear division which occurs after the ascospores are delimited it was of interest to follow this point through the later stages in *Pleurage taenioides* and *P. anserina*. My preparations show regularly only

two nuclei in normal spores of both species. The spore wall thickens rather rapidly so that one cannot be certain from these preparations whether there is a subsequent division of the nuclei. Probably there is not, at least not until germination begins.

Pleurage taenioides can be made to fruit in culture on corn meal agar where spermatia are usually produced rather sparingly. They will be described at another time when other genetic experiments will be reported. In this species many asci have only two large spores. Here one sees four nuclei, often in a row, along the center of the spore.

The spermatial apparatus of *P. anserina* proves to be quite unlike that described by Ames (**1934**) for this species. My material had been carefully identified by Dr. Cain, an authority on this group, and it has also been checked up by the writer. The tufts of stiff hairs or bristles that develop on one side of the perithecial neck is rather characteristic when the fruit bodies are developed on the surface of the medium. It was noticed in some plate cultures, which happened not to have been disturbed, that the tufts on the perithecia had all been developed on the same side with respect to the light exposure. Perithecia which develop below the surface of the agar do not seem to have these tufts. There are other features regarding their development which are interesting, but which require further study.

The writer had considerable trouble in finding asci with five spores although small ascospores are occasionally developed. The percentage of ascospore germination is also very low. It was much easier to obtain unisexual races by isolating single hyphal-tips. On corn meal agar perithecia begin to develop on the fourth or fifth day if the culture originated from a single normal ascospore, whereas if one mates two unisexual races it usually requires much longer.

Originally about 40 single ascospore races were obtained from the culture received from Dr. Cain. When these races were grown on potato-dextrose and dextrose media their mycelia were all very dark colored, but certain races like no. 7 grown on corn meal agar were mottled and somewhat lighter in color (FIG. 1). None of these races produced spermatia at first. When, however, certain unisexual races were grown in plate cultures on corn meal

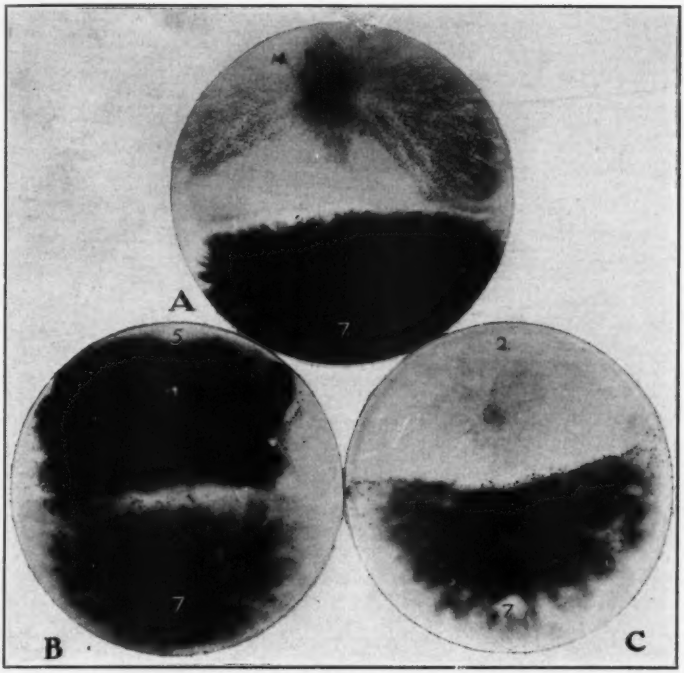

FIG. 1. *Pleurage anserina*. *A*, plate culture of races 14 and 7. Race 14 produces many spermatia, the light colored sectors without spermatia; race 7 does not usually produce spermatia. On dextrose agar the mycelium of this race is very dark, but on corn meal agar it is mottled as shown in *B* and *C*. *B*, mating of race no. 5 with race 7, no spermatia formed by either race in this culture; fertilization due to nuclear migrations from mycelium 7 into 5. *C*, colorless race no. 2 mated with 7. The first perithecia formed along the line of meeting could have been due to natural spermatization but the other perithecia distributed over mycelium 7 must have been due to nuclear migration, as no spermatia could be found on the area covered by race 7 and there was no indication of an overgrowth of mycelium from race 2.

agar, sectoring occurred. The sectors gave colorless mycelia which produced quantities of spermatia. Our races 5 (FIG. 1, *B*), 9, and 19, for example, have been transferred many times to various kinds of agar, but as yet they have not produced spermatia. Spermatia would no doubt form if the races could be made to sector.

Spermatia are usually developed on specialized aerial branches as shown in figure 2, *A–C*. Each cell is potentially a spermogonium just as is the case with *Neurospora*. The flaring inverted bell-shaped aperture for spermatial discharge is usually much longer and more prominent than it is in *Neurospora*. The masses of spermatia are somewhat brownish in color, especially where the spermatial apparatus is composed of olivaceous cells.

Spermogonia are sometimes formed singly along the sides of specialized or thickened hyphae. They are then more or less barrel-shaped (FIG. 2, *D, G*) as figured by Satina. In general, however, spermatia are borne on a rather characteristically branched spermatiophore system as shown in the figure 2, *A–C*.

Some cultures such as no. 14, shown in figure 1, are colorless but appear light brownish where great masses of spermatia are formed. Such mycelia may sector to produce fewer spermatia, or a non-spermatial dark-colored race may sector to produce a colorless mycelium upon which spermatia will be formed abundantly. This process is peculiarly reversible in that a colorless race may revert in part or spots so that the surface hyphae become thick-walled and dark olivaceous to blackish. Such dark hyphae will also develop spermogonia (FIG. 2, *F, G*).

Spermatia are formed on the surface of the medium, yet one finds perithecia with asci deep down in the agar in tube cultures where direct spermatization would be out of the question. Furthermore, perithecia mature in plate cultures where two races which are opposite in their sex-reaction are mated and where neither race produces spermatia. There is no question that fertilization is frequently brought about through nuclear migrations just as it is in comparable matings of *Neurospora tetrasperma* and *Gelasinospora tetrasperma* (**Dodge, 1935**). This can be readily proved by isolating single fragments of hyphae as described in the paper

FIG. 2. *Pleurage anserina*. *A–C*, characteristic spermogonial branches, each cell of which is a spermogonium; the characteristic flaring apex is best shown in C1; *D, F, G*, show spermogonia developing directly from cells of specially differentiated horizontal hyphae, which in these cases were darkly colored olivaceous; *E*, characteristic spermatia; *H, I*, enlarged views of spermogonia showing particularly well the inverted bell-shaped tips suggesting a *Phialophora*. (Various magnifications.)

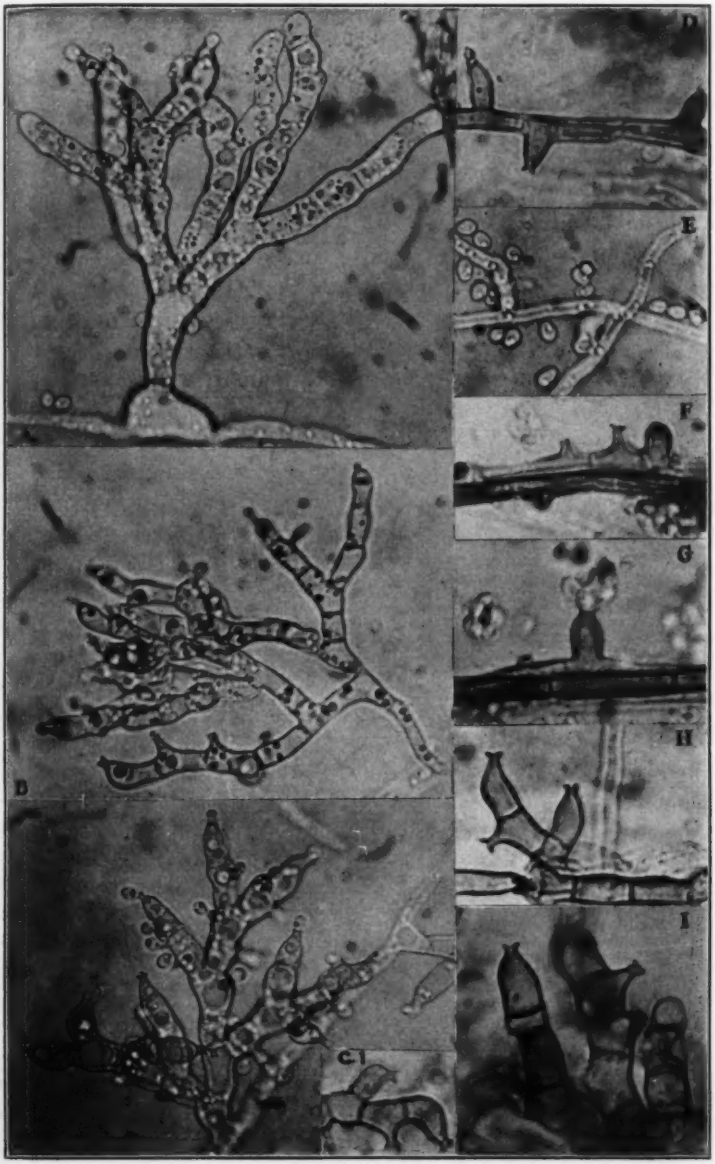

FIG. 2.

referred to. Such fragments are proved totipotent or bisexual when mycelia from them mature perithecia. If there were merely an intermingling of two unisexual mycelia, isolated fragments must always be unisexual. The idea that a mycelium derived from a normal spore containing both kinds of nuclei as to their sex reaction must split up into its two unisexual components so that spermatia from one branch can spermatize trichogynes from some other branch and vice versa has not been supported by any evidence, although that very thing no doubt does occasionally occur in cultures of our facultatively heterothallic species. The point here is that while spermatia of *Neurospora tetrasperma* and *Pleurage anserina* are at times advantageous in fertilization, they are altogether dispensable just as they must be in *Gelasinospora tetrasperma* where spermatia are unknown.

Figure 1, *C* shows a mating of race No. 2 with race No. 7. Race 2 is colorless and produces spermatia rather sparingly. Race 7 seldom produces spermatia, and none could be found on its mycelium in this particular culture. Nevertheless, after about ten days perithecia began to form along the line of meeting of the two mycelia and then others appeared down along the lines of growth of the no. 7 hyphae. The fruit bodies do not show well in this figure because most of them were developed deep down in the agar. Following the method fully described (**Dodge, 1935**) a set of 1-tip isolations was made from each of five different matings. The transplant of course was taken from a region showing perithecia. That nuclear migration in *Pleurage anserina* is much slower and the resulting heterokaryosis or diploidization is less complete than it is in similar cultures of the facultatively heterothallic species of *Neurospora* and *Gelasinospora* is proved by the results obtanied.

In the first test where races 6 and 7 were mated, five 1-tip isolates were proved to be bisexual while twenty-five remained unisexual in their reactions. In a second trial from another culture of the same mating, twenty-one isolates gave perithecia and twelve were proved to be unisexual and so remained sterile. In a mating of races 7 and 8, only one isolate gave perithecia while fifteen were unisexual. Nineteen 1-tip isolates were made from a 7×9 mating and only two isolates gave perithecia. When a transplant was

taken from one of these two cultures and thirty-eight 1-tip isolates were obtained heterokaryosis was found to have become well established, thirty-four isolates giving perithecia and only four were proved to be unisexual.

Certain breeding experiments involving crosses between various races of *Pleurage anserina* have shown that this species is bound to prove highly interesting. Those who undertake this work with fixed notions as to the way things are going to work out, will be disappointed. One would naturally expect to find the nuclear spindles of *Pleurage anserina* to be so oriented as to insure the inclusion of two nuclei of opposite sex-reaction in each spore as they are in *Neurospora tetrasperma*. Satina (**1917**) however, seems to think that the two nuclei included in a spore are sisters. There certainly is great need for further cytologic as well as genetic work with this species.

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A HEART ROT OF MAGNOLIA CAUSED BY FOMES GEOTROPUS

H. W. JOHNSON [1] AND C. W. EDGERTON [2]

(WITH 1 FIGURE)

INTRODUCTION

One of the most beautiful shade trees of southern Louisiana, and a valuable timber tree as well, is the great-flowered magnolia, *Magnolia grandiflora* L. Many old trees of this species are growing on the Louisiana State University campus at Baton Rouge though the number has gradually decreased in recent years due to the attack of a heart-rotting fungus which lowers the vitality of the trees and weakens the trunks to such an extent that the trees are finally unable to withstand the strain of storms. Old trees seriously affected with this disease can be told at a considerable distance. The foliage in the top portion of such a tree is sparse and often some of the upper branches are dead or dying. In general the trees have a " staghead " appearance which is quite noticeable. In recent years attempts have been made from time to time to save some of the trees by tree surgery by cleaning out a portion of the rotted heart-wood and filling the cavities with cement. As would be expected with such a disease, no beneficial effects of the treatment have been noticed.

For several years a pore fungus has been observed fruiting at the base of many of the affected magnolias on the campus. The furiting bodies (FIG. A) usually develop in recesses formed where the main roots join the trunk and hence are frequently abnormal in form. Typical bracket forms, however, have been found on the inside of a hollow magnolia stump and also on the inside of

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hollow trees and the fungus has been identified as *Fomes geotropus* Cooke.

The fruiting bodies used in making this identification were sent to L. O. Overholts of Pennsylvania State College who verified the determination and wrote that these were the largest fruiting bodies of *F. geotropus* he had ever seen and that magnolia was a new host record for this fungus. The fungus appears to be a wound parasite and possibly basal fire burns or other injuries have been responsible for exposing the heartwood to attack. Apparently this heart rot of magnolia has not previously been described.

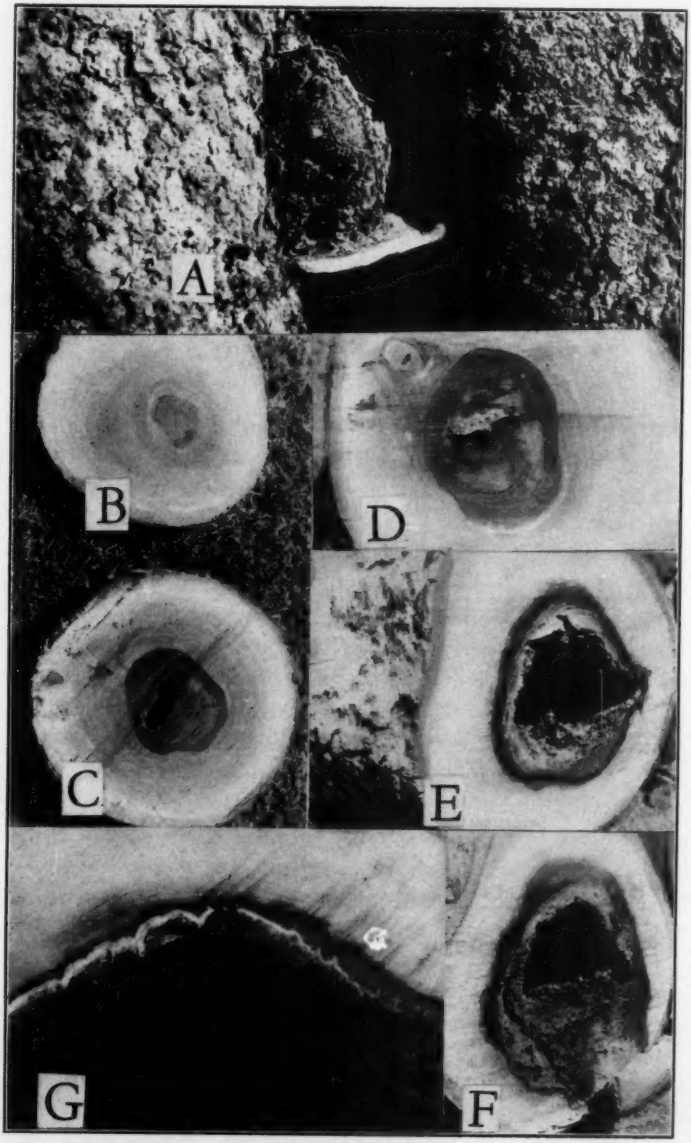
DESCRIPTION OF HEART ROT

The following description is based upon a detailed examination of a large magnolia much weakened by heart rot which fell in December, 1929, while heavily loaded with ice following a sleet storm.

The storm was one of the most severe on record. Ice about a half inch thick covered all the leaves and branches. It seemed of interest to determine the amount of ice being held up by one of these trees. The ice on a number of leaves was weighed and it was found that there was an average per leaf of about 90 grams. Counting 30,000 leaves to the tree, this gave a total weight on the leaves of about three tons. Including the ice upon the twigs and branches, it seems quite probable that the total ice load per tree weighed between three and a half and four tons. It is not surprising that a tree severely weakened by a heart rot should fall under such a strain.

The trunk of the fallen tree was cut into logs and thin cross sections were sawed off at various heights and taken into the laboratory for study. The amount of rot at various points in the trunk is shown by the pictures of these cross sections (FIG. B–F).

In magnolia the typical mature rot is brown in color. In its incipient stage, the rot is grayish-black with distinct greenish and reddish tinges when freshly cut surfaces are exposed to the air. The normal magnolia heartwood is creamy white. Black zone lines are conspicuous near the advancing edge of the rotted area. Figure G shows these zone lines and the fungous mycelium which grew from the rotted wood just behind them when the cross sec-


A
B
D
C
E
G
F

tions of the trunk were taken into the laboratory and kept for several days in a rather humid place.

Termites and other wood-boring insects were found abundantly in the rotted heartwood and appeared to be playing a part in the final reduction of the wood to a soft, brown, crumbling mass which gradually fell out, leaving a central cavity. In the tree studied, this cavity tapered upward from a diameter of 36 inches at the base to a slit-like hollow approximately 4 inches long and 1 inch wide at a height of 20 feet above the ground. The rot had broken out on one side of the trunk and the cavity was open to a height of 14 feet. The opening tapered from 24 inches in width at the base to 8 inches in width at a height of 13 feet and then closed rather abruptly.

From the point slightly above 20 feet where the central cavity ended, the rotted area surrounded a shake in the heartwood which extended to a height between 38 and 40 feet. The rot surrounding the shake was all in the incipient stage (grayish-black color). Distinct zone lines darker in color were found at the edge of the rotted area in this portion of the trunk as well as in the region of mature rot nearer the base of the tree.

SUMMARY

A heart rot of *Magnolia grandiflora* L. which appears to be responsible for the destruction of many of the old trees of this species in southern Louisiana is described.

A pore fungus, *Fomes geotropus* Cooke, has been found constantly associated with the heart rot and is evidently its cause.

Apparently this is the first record of this fungus attacking *Magnolia grandiflora*.

DEPARTMENT OF BOTANY,
LOUISIANA STATE UNIVERSITY,
BATON ROUGE, LOUISIANA

FIG. 1. *A*, *Fomes geotropus* growing at base of trunk of *Magnolia grandiflora; B–F*, sections of log of *Magnolia grandiflora* affected with heart rot: *B* at 23 feet, *C* at 20 feet, *D* at 18 feet, *E* at 15 feet, and *F* at 10 feet from basal end; *G*, mycelium of *Fomes geotropus* growing out of rotted area in heart wood of *Magnolia grandiflora* after section of log was cut and kept moist for several days.

NOTES AND BRIEF ARTICLES

Chronica Botanica

There are nearly 4,000 Institutions of pure and applied botany. There are between 60,000 and 70,000 botanists. There are about 1,000 periodicals concerned with botany! How can you keep in touch with all this activity? How can you find out what other botanists are doing and what new work they are planning. Chronica Botanica will help you. Subscribe to it and help with the compilation of the next volume.

All directors of institutions and secretaries of societies will receive a copy of our questionnaire at the beginning of December of each year. Replies should reach the Editor-in-Chief, Dr. F. Verdoorn, Leiden, Holland, not later than January 30th, as it will generally be impossible to make use of information received after that date. Directors or Secretaries, who do not receive our preliminary circular, which will reach them annually before Oct. 15th, are kindly requested to acquaint us of the fact at their earliest convenience, which will enable us to include them in our mailing list, and will ensure their receiving a copy of the questionnaire in December.

Prospectus, sample pages and further information may be had from the Editorial and Publishing Office, P. O. Box 8, Leiden, Holland.

Illustrations of Myxomycetes

Under the title "Myxomycetes of Nasu District" Dr. H. Hattori has just issued one of the most attractive volumes on the slime

molds that has ever been published. The text is in Japanese, but in addition to the reproduction of several figures by other authors there are 306 original photographs, illustrating habit and microscopic characters of the 124 species listed, and thirty-three colored plates, one after a water color by Miss Lister, the others evidently original, containing in all 128 figures. In accuracy and beauty the colored illustrations rival those of Miss Lister and Mr. Crowder, and constitute a contribution of permanent value to the iconography of the group.—G. W. MARTIN.

A. J. Mix, Department of Botany, University of Kansas, wishes to obtain freshly collected material of *Taphrina* (including *Exoascus* and *Magnusiella*). In return he will be willing to undertake special collection of fungi locally available. Special interests include: *Taphrina coerulescens* on all possible species of oaks, plum pockets on wild and cultivated plums, and any species of *Taphrina* on ferns. Specimens should be collected in ascus-bearing condition, pressed for 24 hours and then mailed.

SUMMER FORAY

The Summer Foray will be held at the Mountain Lake Biological Laboratory, Mountain Lake, Va., **Sept. 3–5th.** You are asked to bring your blankets, sheets, and towels if you intend to make headquarters at the Laboratory. The rates are $2.00 per day. The nearest hotel is 2 miles away and somewhat expensive, while more reasonable accommodations may be found in Blacksburg, 20 miles away. It is hoped that as many as possible will stay at the Laboratory.